WINDOWS 11: 7 UNEXPECTED FEATURES

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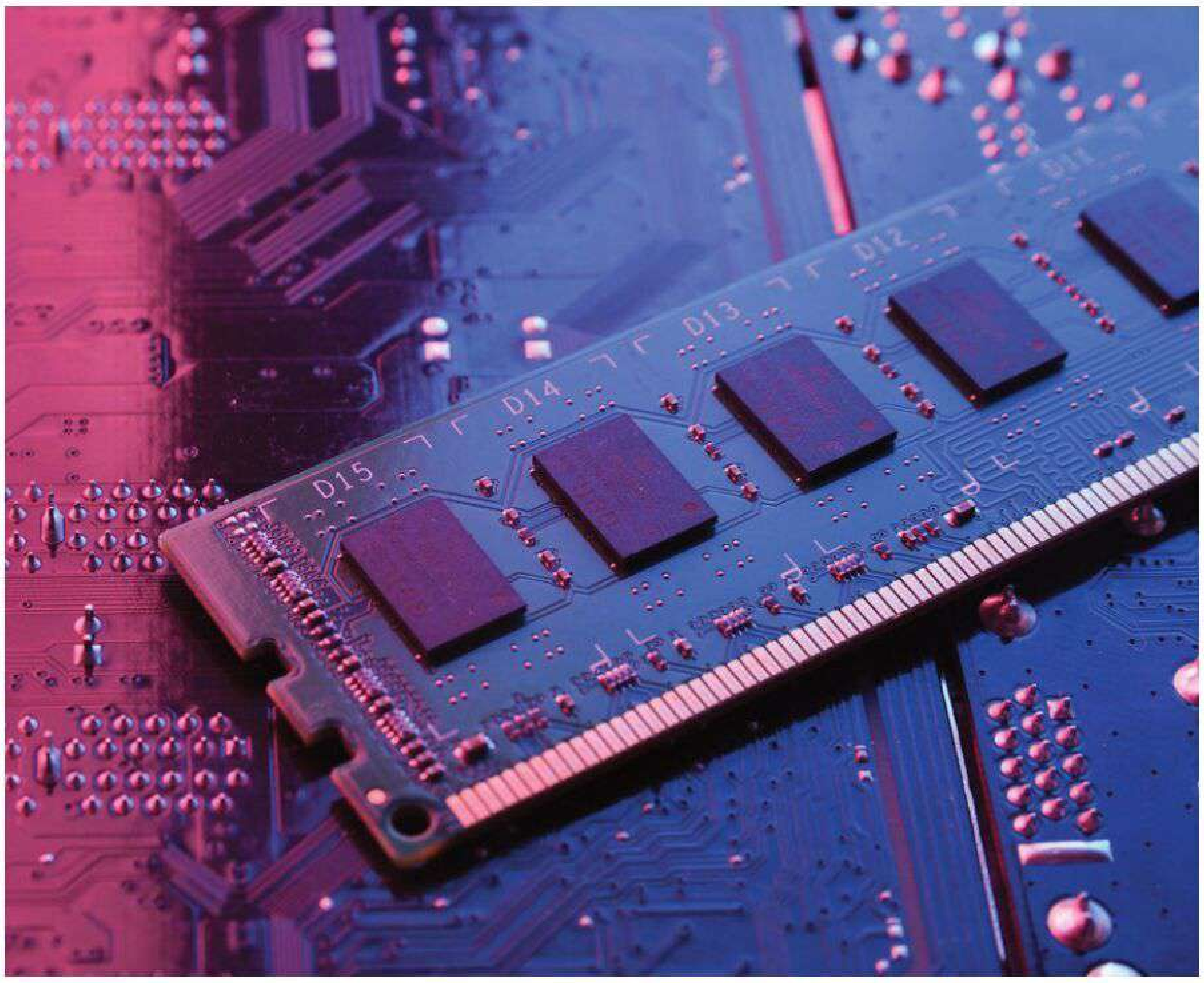

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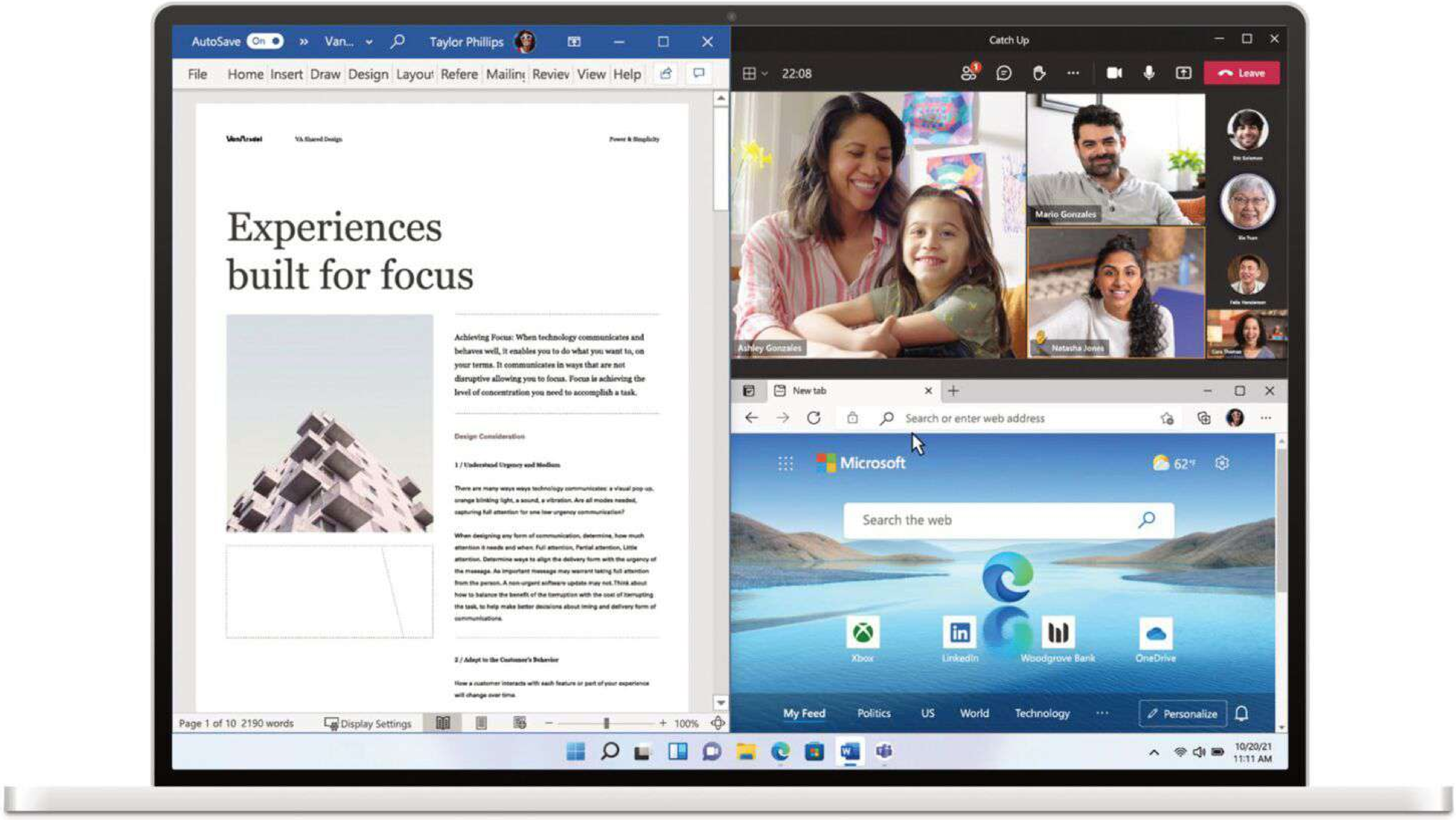
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Windows 11 to launch on October 5

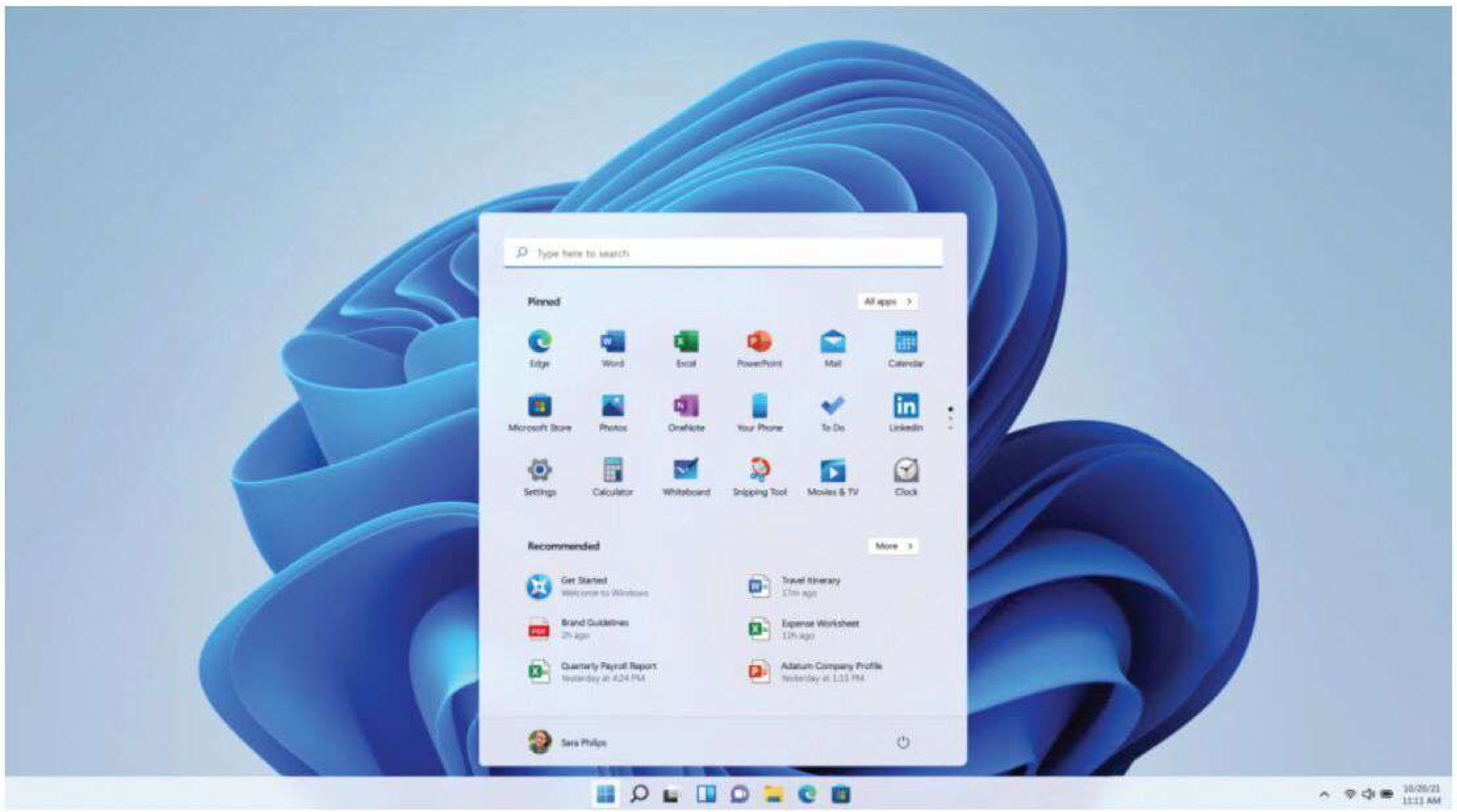
The start of an exciting fall for PC users. **BY BRAD CHACOS**

It's official: Windows 11 will be released on October 5. "On this day, the free upgrade to Windows 11 will begin rolling out to eligible Windows 10 PCs and PCs that come pre-loaded with Windows 11 will start to become available for purchase," Microsoft said at the end of August (go.pcworld.com/stdy).

That's an interesting twist, as Microsoft previously said that Windows 11 upgrades for Windows 10 PCs wouldn't happen until 2022 (go.pcworld.com/up22). Will those eligible PCs start seeing the Windows 11 upgrade prompt immediately, or will most people need to wait until later for the offer? We'll have to see—and that's not even getting into the Windows 11 hardware compatibility fiasco (go.pcworld.com/cmfs) for desktop users, which started off confusing and just keeps getting more confusing. Microsoft says new devices will get offered it first, with Windows 11 spreading to all eligible PCs by mid-2022.

Don't let those technical details take your eyes off the prize though. Whenever you wind up eligible for it, Windows 11 brings a lot of fresh features to the table. You'll notice the differences immediately upon booting up: Microsoft overhauled the look and feel of the operating

IMAGE: MICROSOFT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Welcome to Windows
Travel Itinerary
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Expense Worksheet
Quarterly Payroll Report
Adatum Company Profile
Sara Philips

Microsoft has overhauled the look of Windows 11, with a simplified Start menu.

system, with a new center-aligned taskbar and a simplified Start menu with no Live Tiles. It's a big change. And most of the core Windows apps you use every day are getting fresh paint and fresh functionality, too (go.pcworld.com/frpt).

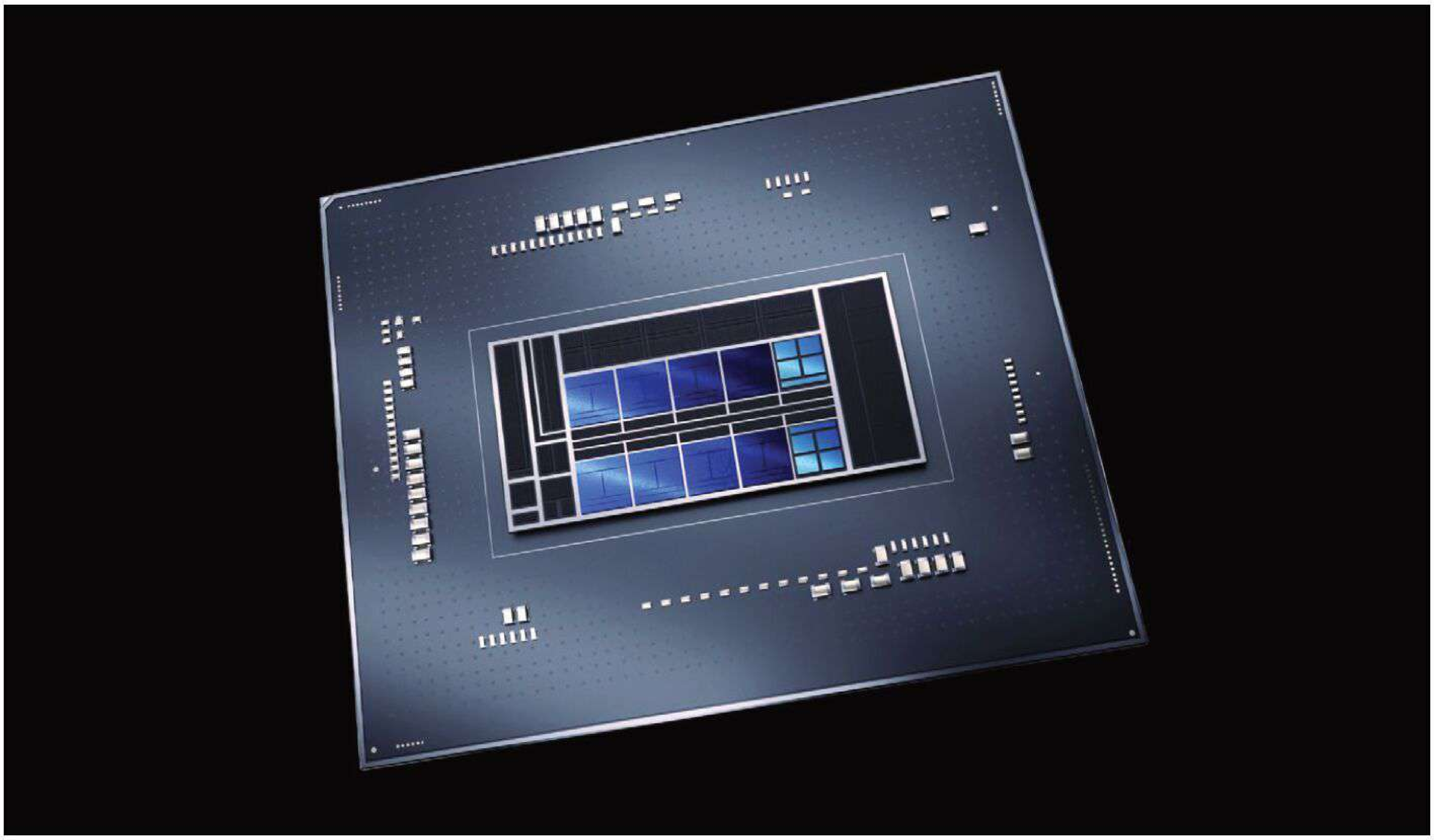
The changes aren't just skin-deep, though. You'll be able to run Android apps in Windows 11 courtesy of Amazon's app store, widgets are coming back, and exciting game-boosting technologies like Microsoft DirectStorage and AutoHDR will be baked into the operating system, as our guide to 8 new Windows 11 features we didn't expect details—see page 25. The Microsoft Store is receiving a sorely needed overhaul, too.

As a nerd, I'm excited about how Windows 11's Snap feature will include expanded functionality from Microsoft's wonderful Fancy Zones PowerToy app. I'm also interested in the smarter way the operating system will handle windows on displays that shut down—they won't just all cram into your main monitor anymore, and instead will smartly minimize and reopen if you turn your second monitor back on. *Finally*. That overly streamlined File Explorer implementation looks suspect, though.

Our hands-on preview of Windows 11 (go.pcworld.com/pv11) can walk you through our thoughts around the most significant changes, while our Windows 11 FAQ (go.pcworld.com/11fq) answers all the questions you might be asking. If you want a higher-level overview of what's coming, be sure to check out our guide to 7 big changes in Windows 11 (go.pcworld.com/7big).

And take note, hardware enthusiasts: Windows 11 includes the Thread Director software necessary to coax full performance out of Intel's upcoming Alder Lake desktop chips (see page 9), a radical redesign of the chip architecture designed to strike back at AMD's Ryzen resurgence.

Windows 11's October 5 release is teeing up an exciting fall for the PC. We don't have long to wait.



Intel's radical new Alder Lake CPUs were built for Windows 11

They were designed specifically with Windows 11 in mind. **BY MARK HACHMAN**

Intel's next PC microprocessor, Alder Lake, marks a radical change for Intel. Its first mainstream Core hybrid processor mixes performance and efficiency engines to deliver either performance or longer battery life when your PC needs it most.

According to Intel, Alder Lake is due "later this fall," most likely as a 12th-gen Core chip. Intel will manufacture three versions of Alder Lake—one for the desktop, and two more for laptops—with up to 16 cores and 24 threads. Alder Lake will also mark Intel's introduction of PCI Express 5 and DDR5 memory, executives said at its Intel Architecture Day Thursday.

Interestingly, Intel has co-designed with Microsoft a special thread scheduler, destined for Windows 11, that will optimize performance. Desktop and laptop PCs with Alder Lake inside them should mix and match higher performance where it's needed and offer longer battery life, as Intel continues to get better at assigning the right processor core for the right task. The company says its

IMAGE: INTEL

performance core should deliver 19 percent more performance than today's 11th-gen "Rocket Lake" desktop chip (go.pcworld.com/rlke).

The bottom line? It's probably fair to say that a major overhaul of the Intel Core PC is in the works for this fall.

WHAT IS ALDER LAKE?

Alder Lake, Intel's next-gen Core architecture, will ship this fall inside desktop and mobile PCs. Intel will offer one two-chip socketed desktop processor, plus two mobile chips: one for mainstream PCs, and one for thin-and-lights and tablets. They're all built on Intel's newly renamed Intel 7 process (go.pcworld.com/i7pr), from 9-watt tablets to 125-watt desktops.

Alder Lake configurations will look like this, below. (Intel also uses the term P-Cores to describe performance cores and the term E-Cores to describe the low-power efficiency cores.)

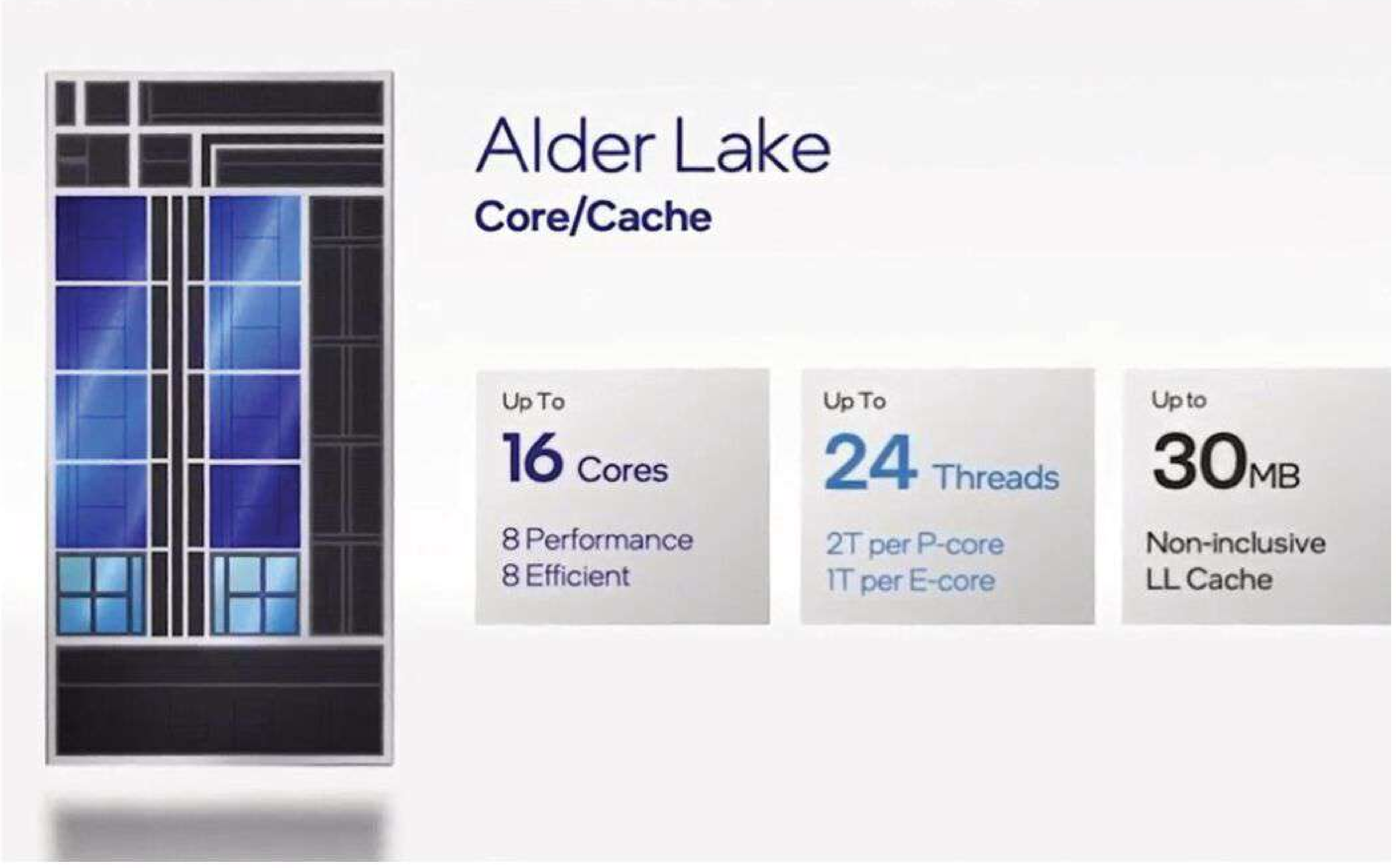
Desktop: 8 performance cores, 8 efficiency cores

Mobile: 6 performance cores, 8 efficiency cores

Ultramobile: 2 performance cores, 8 efficiency cores

When Intel first disclosed Alder Lake last August (go.pcworld.com/1std), we knew then it wouldn't be a traditional Intel processor. Inside are two types of processing cores: a performance core that will turn on for applications like games, and an efficiency core used for typical background tasks, like email syncing.

Arm has used this hybrid approach for many years, and the niche Intel Lakefield processor (go.pcworld.com/lkfd) did as well. Neither excelled at performance. Raja Koduri, Intel's senior vice president of its AXG group, sought to differentiate Alder Lake (go.pcworld.com/sf90), calling it a "performance hybrid"—think Ferrari SF90 Stradale rather than Toyota Prius.



Alder Lake
Core/Cache

Up To
16 Cores
8 Performance
8 Efficient

Up To
24 Threads
2T per P-core
1T per E-core

Up to
30MB
Non-inclusive
LL Cache

A summary of Intel's Alder Lake chip. Note that hyperthreading, a staple of most modern PC microprocessors, is available only on the performance cores.

Scalable Client Architecture
Desktop
LGA 1700
Socket
Mobile
BGA Type3
50 x 25 x 1.3 mm
Ultra Mobile
BGA Type4 HDI
28.5 x 19 x 1.1 mm

Intel's Alder Lake chips will be manufactured for three different classes of PCs.

Alder Lake does not use Arm cores. Intel's performance cores use Intel's traditional Cove CPU design, and the efficiency cores use Intel's Atom design.

Intel Architecture Day was for chip nerds. We'd expect Intel Innovation, a show Intel will hold on October 27 as a replacement for the venerable Intel Developer Forum, to answer the questions chip buyers will want answered: how fast Alder Lake will run, what the branding and model numbers will look like, and how much these chips will cost.

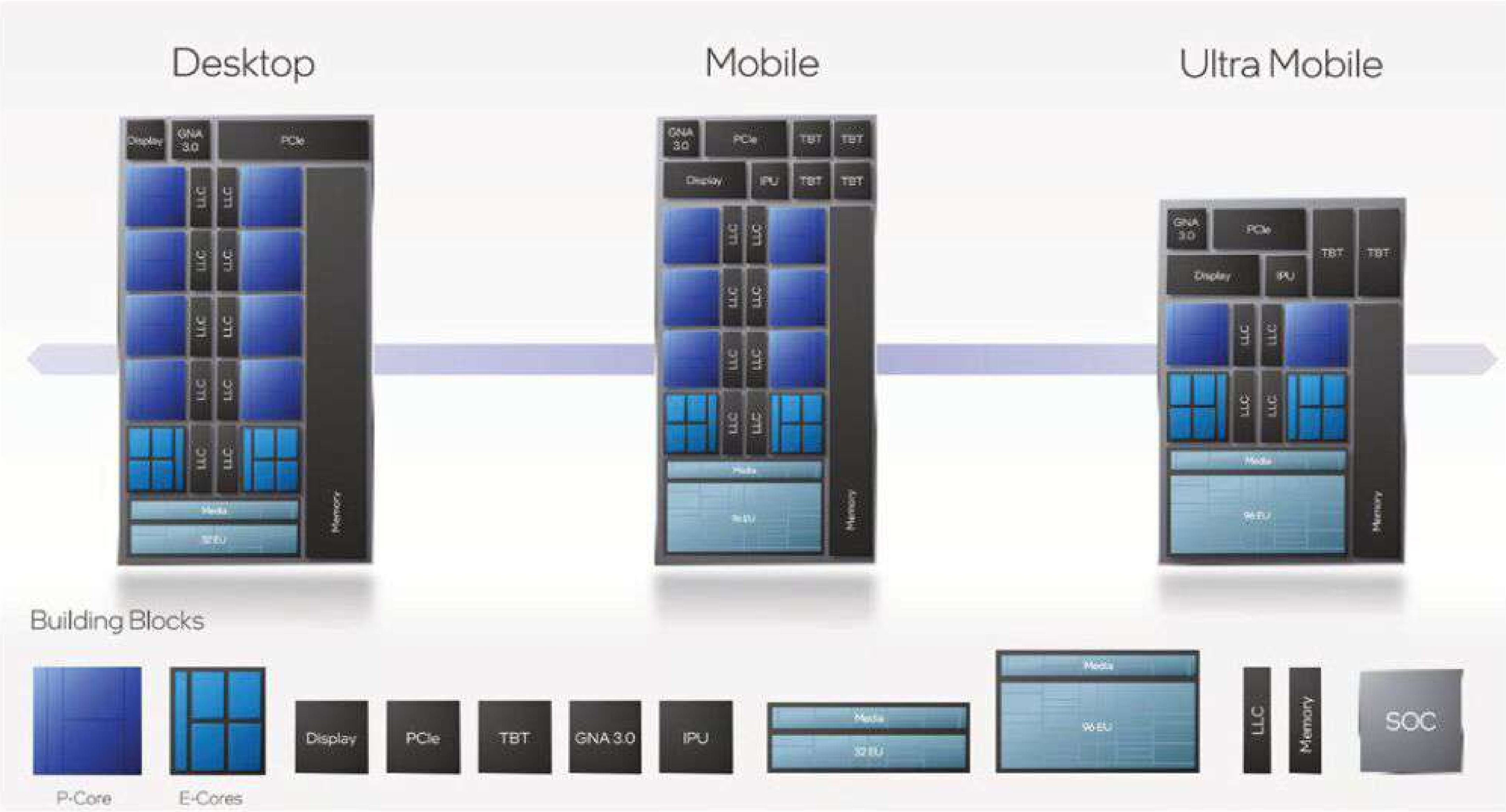
MAJOR CHANGES COMING WITH ALDER LAKE PCS

We already know of major changes affecting how Alder Lake PCs will be built, especially by DIY PC builders. For one, Alder Lake's desktop processor will use an LGA1700 socket, an open secret that has surfaced as board makers and chip cooler makers design around the new chip (go.pcworld.com/opsc). The larger LGA1700 socket replaces the standard LGA775 socket used for well over a decade in the PC space, which means you will need to buy a new motherboard and cooler if you're building an Alder Lake PC.

Alder Lake also uses a hybrid physical memory interface that supports four different memory types: DDR4-3200, LPDDR4x-4266, and also the brand-new DDR5 technology and its DDR5-4800 and LPDDR5x modules. (DDR5, a new memory technology developed in 2017, has been in the works for years [go.pcworld.com/wkyr[, though it's arrived a bit later than expected [go.pcworld.com/wkyr].) Arik Gihon, the chief architect of Alder Lake, told attendees that Alder Lake will be able to clock the memory speed up or down, saving power, in response to real-time heuristic analysis of the work that's being performed. Intel's Alder Lake will offer you the option of buying new, hotter, more expensive DDR5 memory, but you should also have the option of reusing your older PC memory.

Just as your car's engine is really a collection of individual parts, so are Intel's chips becoming a collection of individual logic blocks packaged together in various ways. Gihon referred to them as "building blocks," and showed off some of the unexpected differences between the desktop and mobile chips. In the diagram below, for example, you can see that the desktop Alder Lake chip lacks Thunderbolt capabilities and has a smaller number of integrated graphics cores than the mobile Alder Lake chips do.

Finally, Intel's Alder Lake will include Intel's first support for PCI Express 5, announced in 2019 (go.pcworld.com/xpr5). PCIe Gen 5 supports up to twice the bandwidth of PCIe 4, or 64GBps across 16 lanes. That, of course, will be likely gobbled up by both graphics cards and SSDs. An early snapshot of the Alder Lake chipset shows it offering x16 PCIe Gen 5 for graphics cards and a x4 connection to PCIe Gen 4 for SSDs.



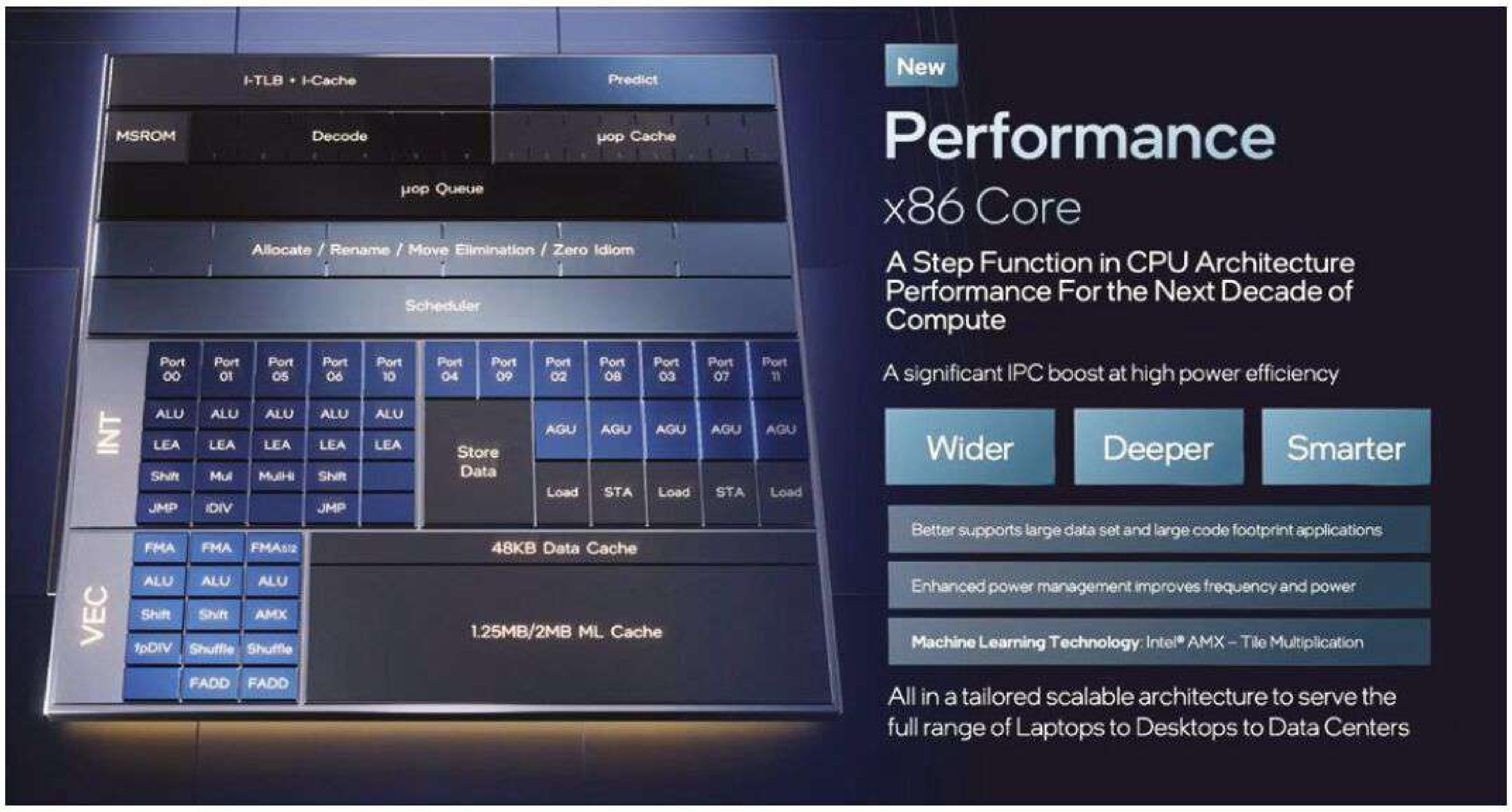
According to Daniel Rogers, the product manager for Alder Lake, the presence of fewer Xe EUs (32, as opposed to 96) on the desktop processor assumes the presence of discrete graphics. Note that Alder Lake supports up to four Thunderbolt 4 ports as well as Wi-Fi 6e.

Alder Lake's overall performance remains somewhat of an open question. Remember that Intel's first attempt at a hybrid processor architecture, Lakefield, came and went with reports of poor performance. We do have the first inkling of how Intel's performance core will perform, however.

INTEL'S NEW PERFORMANCE CORE

Intel's performance core, or P-Core, is essentially the legacy of its Core chips, carried forward into Alder Lake. We often refer to Intel's microprocessors by their code names—Skylake, Rocket Lake—but Intel has its own internal code names for just its CPU cores, too: the little-used Sunny Cove code name, for example. Officially, this is Golden Cove, but you'll see it referred to merely as just a performance core. But, according to Intel's Koduri, this is the core that's designed for pure speed.

According to Yadi Goaz, the director of the Intel Core CPU architecture, the performance core was designed to step up in general single-threaded CPU performance, but also anticipate the needs of


I-TLB + I-Cache
Predict
MSROM
Decode
µop Cache
µop Queue
Allocate / Rename / Move Elimination / Zero Idiom
Scheduler
INT
Port 00
Port 01
Port 05
Port 06
Port 10
Port 04
Port 09
Port 02
Port 08
Port 03
Port 07
Port 11
ALU
LEA
Shift
Mul
MulHi
JMP
iDIV
Store Data
AGU
Load
STA
VEC
FMA
FMA512
AMX
Shuffle
fpDIV
FADD
48KB Data Cache
1.25MB/2MB ML Cache

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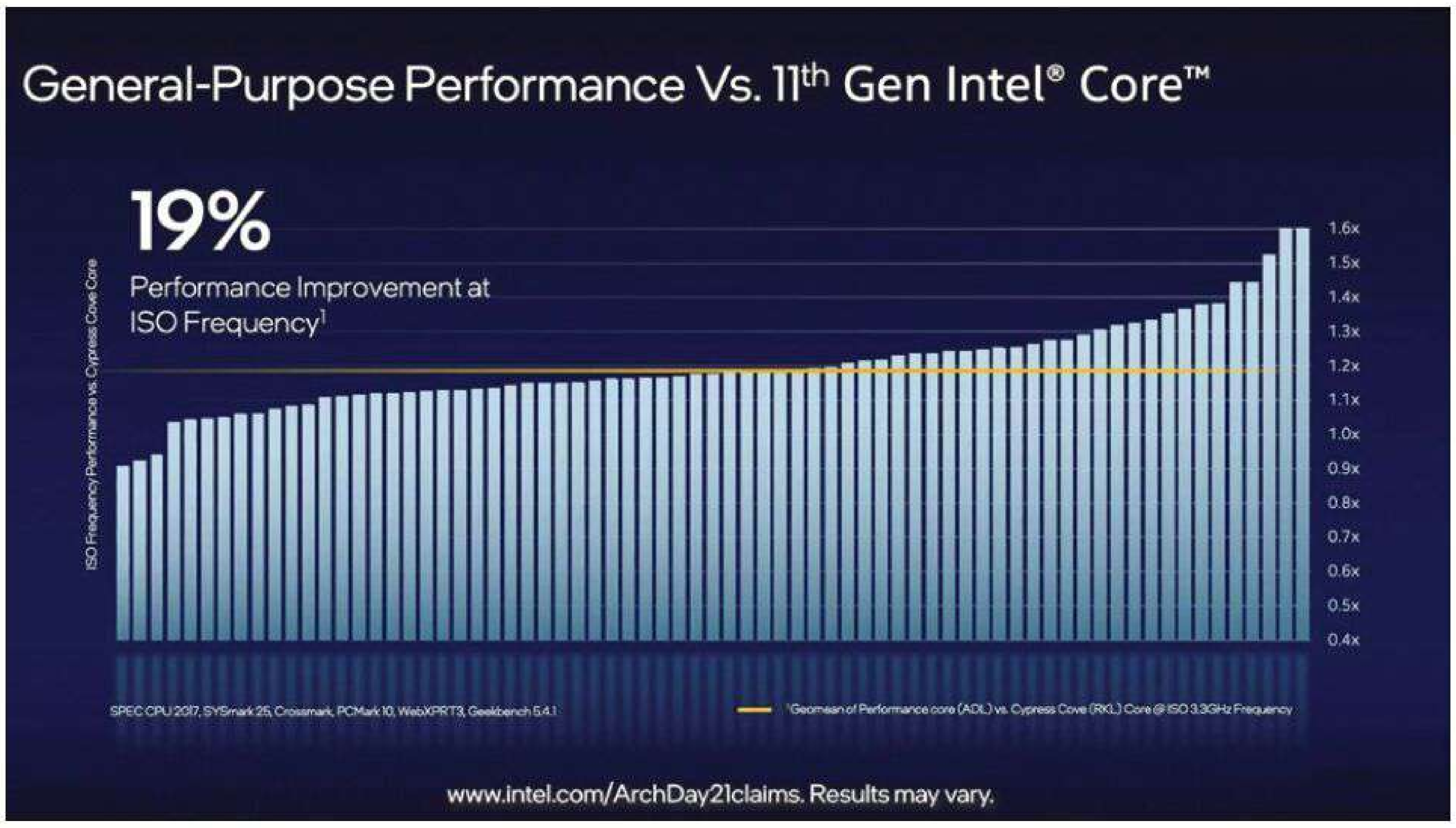
An overview of Intel's performance core within Alder Lake.

artificial intelligence and other functions in laptops, desktops, and servers. Intel solved the latter problem with a new AI matrix engine coprocessor. It has a new smart power management controller, too.

While Goaz delved deep into the intricacies of the design, there are a few broad takeways: The P-Core is essentially wider and deeper than before, with the ability to perform better branch prediction for applications with a lot of code. The chip's caches have been improved to better accommodate data misses. The performance core also integrates a new microcontroller that can examine the needs of applications in a microsecond—that's even faster than a millisecond. "The result is higher average frequency for any given application," he said.

Goaz said that Alder Lake's performance core will offer a 19 percent improvement over the Cypress Cove core found in Rocket Lake, based on a variety of conventional, current benchmarks: Spec CPU 2017, Sysmark 25, PCMark 10, and more. That comparison is based on running both chips at the same frequency, 3.3GHz. "This level of improvement is even greater than what we



General-Purpose Performance Vs. 11th Gen Intel® Core™

19%

Performance Improvement at ISO Frequency¹

SPEC CPU 2017, SYSmark 25, Crossmark, PCMark 10, WebXPRT3, Geekbench 5.4.1

¹Geomean of Performance core (ADL) vs. Cypress Cove (RKL) Core @ ISO 3.3GHz Frequency

www.intel.com/ArchDay21claims. Results may vary.

This is how Intel views the performance of its performance core within Alder Lake.

delivered with the Sunny Cove core over the Skylake core," Goaz said.

At the Hot Chips conference on August 23, Intel executives said that the P-Core offers 50 percent more performance over the E-Core, according to the Anandtech live blog of Intel's presentation (go.pcworld.com/lvbl).

For new applications, Intel developed a set of new instruction extensions, called Advanced Matrix Extensions, or AMX. AMX was designed for machine learning and AI, both of which have become selling points for hardware for the data center.

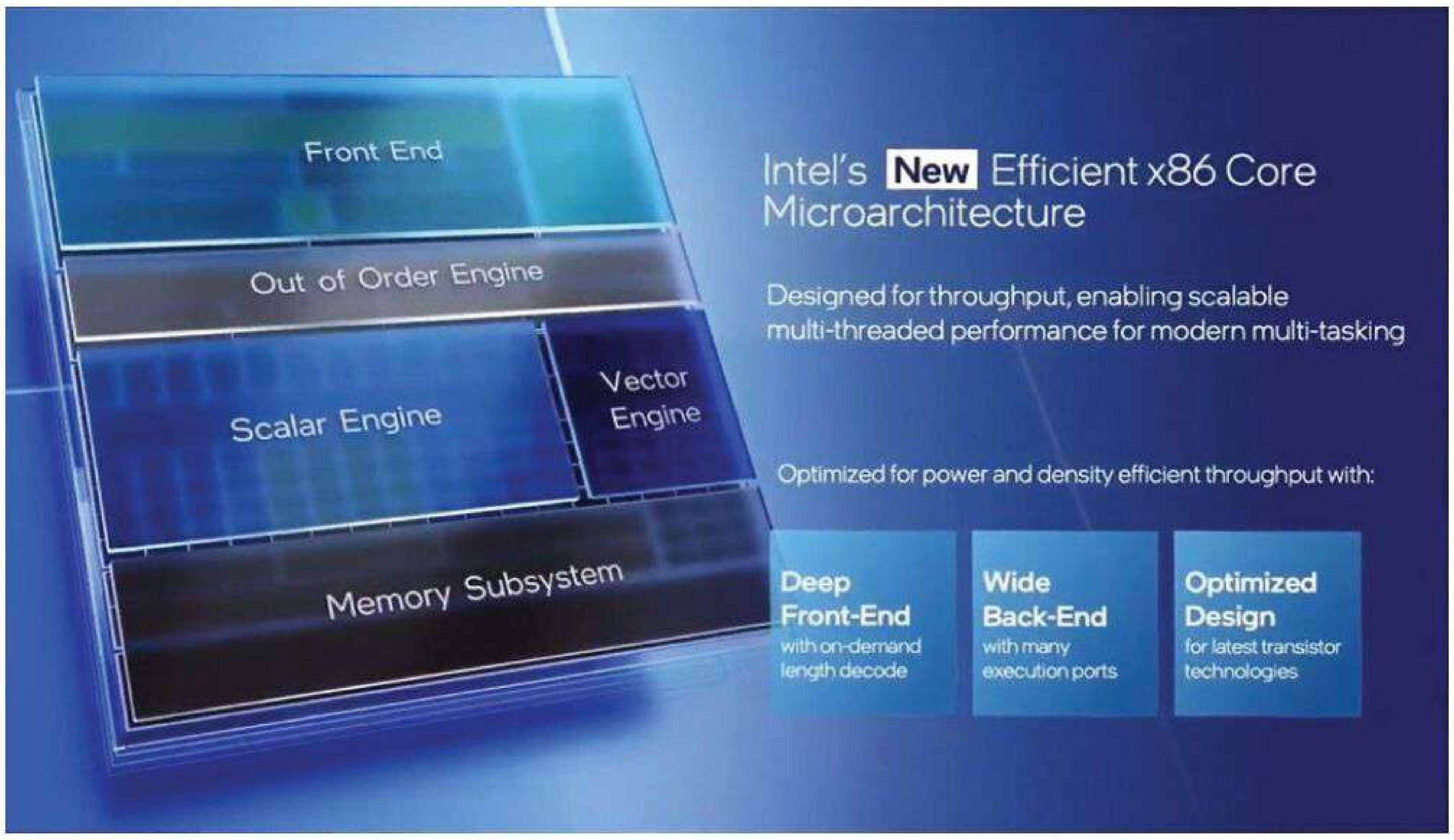
Why even develop desktop Alder Lake chips with efficiency cores? "You're absolutely right—battery life doesn't matter in desktop," said Stephen Robinson, a CPU architect and Intel fellow. "But the thermals do. Fans, cooling power—at some point, you have a limit." And that's why Intel designed its new efficiency cores.

INTEL'S NEW EFFICIENCY CORE

The first thing you need to know about Intel's efficiency core is that…well, it's a performance core, too, of a sort. Formerly named Gracemont, the Intel efficiency core is essentially a fourth-generation Atom chip that lacks the hyperthreading capabilities of the Intel performance core. "Our primary goal was to build the world's most efficient X86 core, while still delivering more instructions per clock than Intel's most prolific architecture to date," Robinson said.

That architecture was the sixth-generation Intel Skylake chip (go.pcworld.com/sxgn), and Intel's efficiency core apparently supersedes it in every way. Four of the E-Cores (also manufactured in Intel's Intel 7 process) take up the die space of a single Skylake core.

The new E-Core also delivers 40 percent more performance than Skylake. If you put four E-Cores against a dual-Skylake system using four threads, you'd still get 80 percent more performance with less power, Robinson said. "We exceed Skylake Core performance by consuming less power in a smaller footprint," he added.



Intel's **New** Efficient x86 Core Microarchitecture

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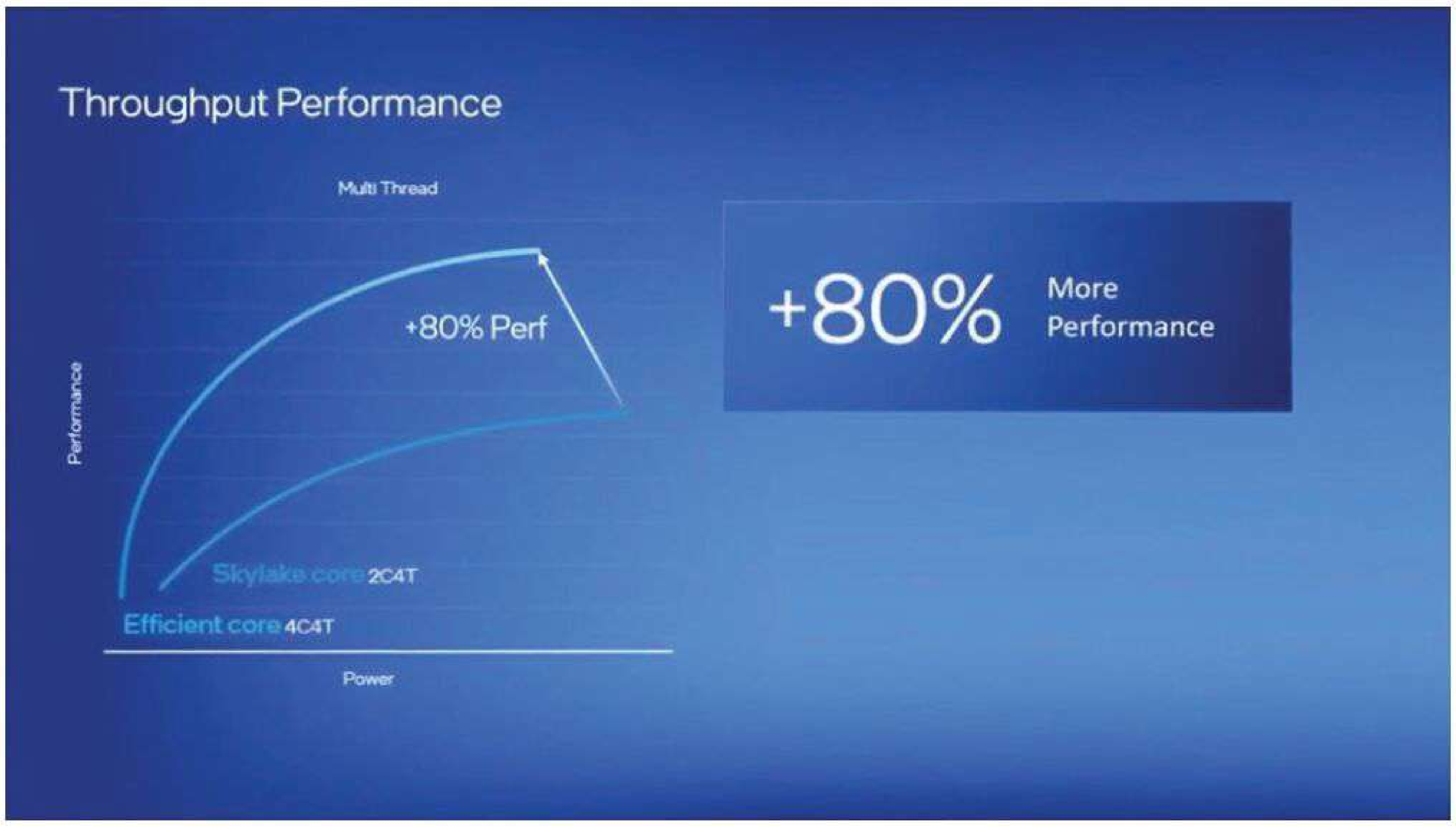
Optimized for power and density efficient throughput with:

Deep Front-End with on-demand length decode

Wide Back-End with many execution ports

Optimized Design for latest transistor technologies

An overview of Intel's efficiency core within its Alder Lake chip.



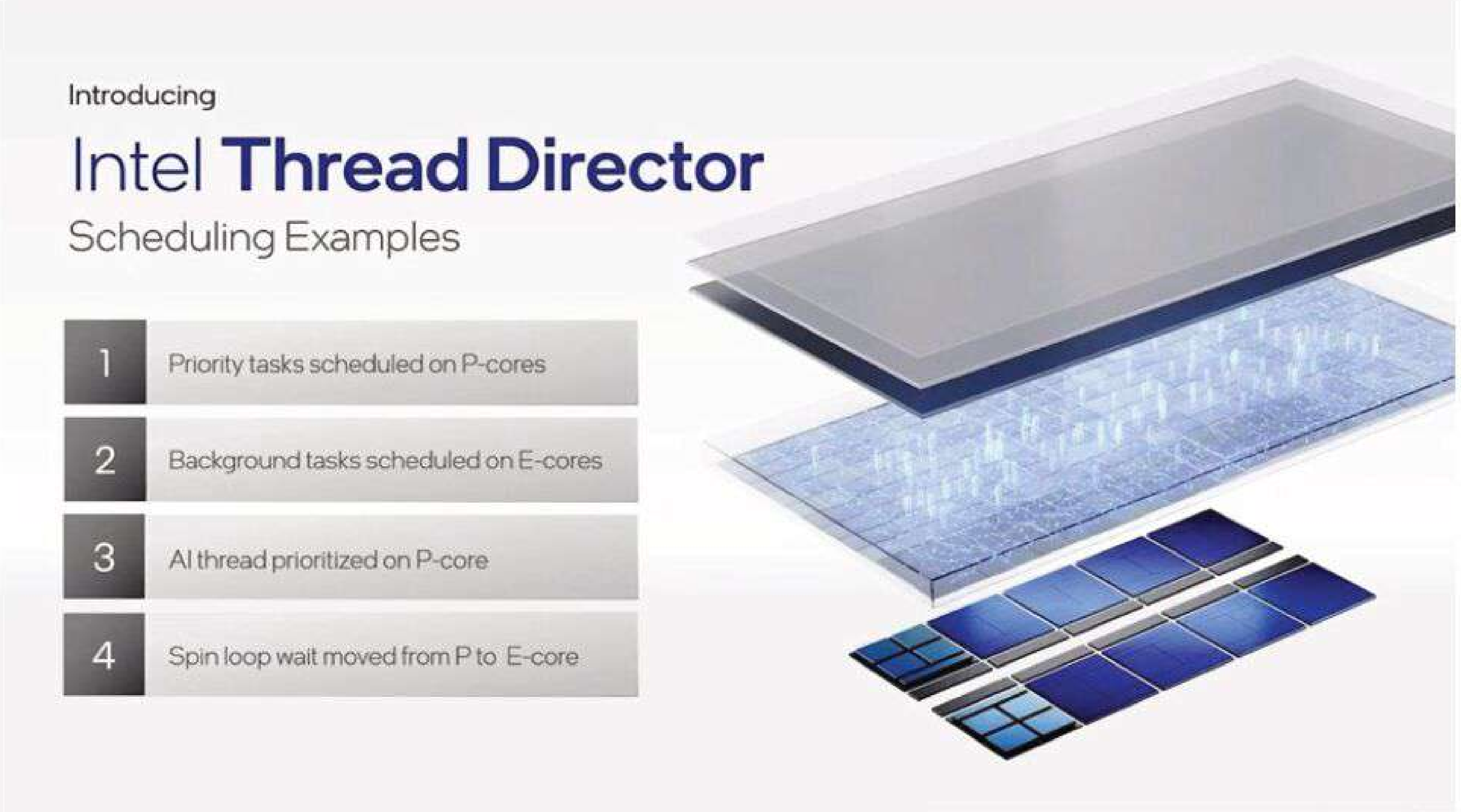
INTEL THREAD DIRECTOR: HOW IT ALL FITS TOGETHER

Intel's Thread Director is a thread scheduler, a sort of traffic cop in the operating system, ensuring that high-priority operations are dealt with first, and making sure that a microprocessor isn't starved for data. With Alder Lake, the question becomes: Which task goes first, and on which processor core type should it run?

That's the job of the Thread Director, an Intel-designed scheduler specifically designed for Windows 11. Until now, apps running in the foreground (such as the web browser you're using to read this story) were assigned the highest priority by default.

Thread Director goes a step further, analyzing the performance needs of each thread, assigning them to the right type of core—and then reassigning them on the fly if new threads appear. Rajshree Chabukswar, the senior principal Intel engineer in charge of the effort, said Thread Director will manage common consumer tasks like gaming, streaming, productivity apps, and more. Because Intel Thread Director is running in hardware, not software, developers won't have to try to assign these priorities themselves.

Interestingly, there may be scenarios where the E-core offers higher performance than the P-Core, or where the P-Core is actually more efficient. The actual frequency at which these cores run will be adjusted according to the


Introducing

Intel **Thread Director**

Scheduling Examples

1 Priority tasks scheduled on P-cores
2 Background tasks scheduled on E-cores
3 AI thread prioritized on P-core
4 Spin loop wait moved from P to E-core

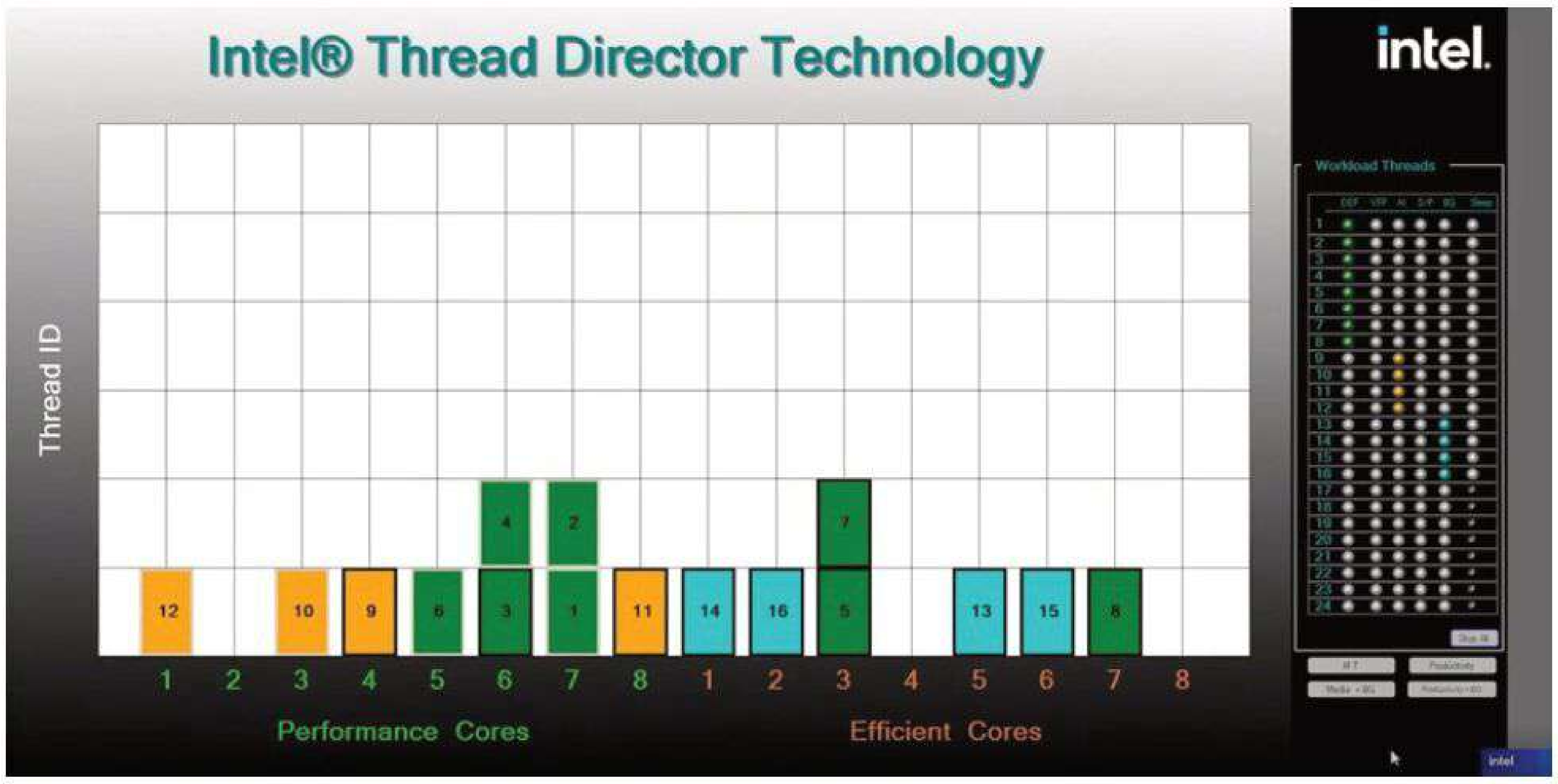
compute load and balanced between the different core types. Background threads will run at a low clock frequency, and high-priority threads will run at a higher frequency, Intel said at the Hot Chips conference. All AI workloads will be assigned first to P-Cores, according to the Anandtech live blog.

Some questions remain. For one, there's the timing: According to Chabukswar, Thread Director support will be incorporated into the "upcoming Windows 11 release," implying that Windows 11 should support Alder Lake at launch. But it's still not clear whether Windows 10 will enjoy the same support. Chabukswar said there's still "hybrid goodness" with Windows 10, but added that Windows 11 will provide the ability to dynamically shift threads back and forth between performance and efficiency cores. It sounds like Windows 10 may lack that capability, making the combination of Windows 11 and Alder Lake that much more efficient.

"The ordering of thread scheduling and other things are taken care of in Windows 10," Chabukswar said. "Windows 11 takes it to the next level."

Chabukswar also implied that Alder Lake will run differently on Windows 10 versus Windows 11, but it might not be as straightforward as seeing higher performance scores. Instead, she said a Windows 11 system with Thread Director enabled may be more efficient in bouncing tasks back and forth between the performance and efficiency cores. The results may be hard to quantify: With low-priority tasks handed off to E-cores, will performance improve as the P-Cores are freed up? Or will battery life lengthen? It may all take some testing.

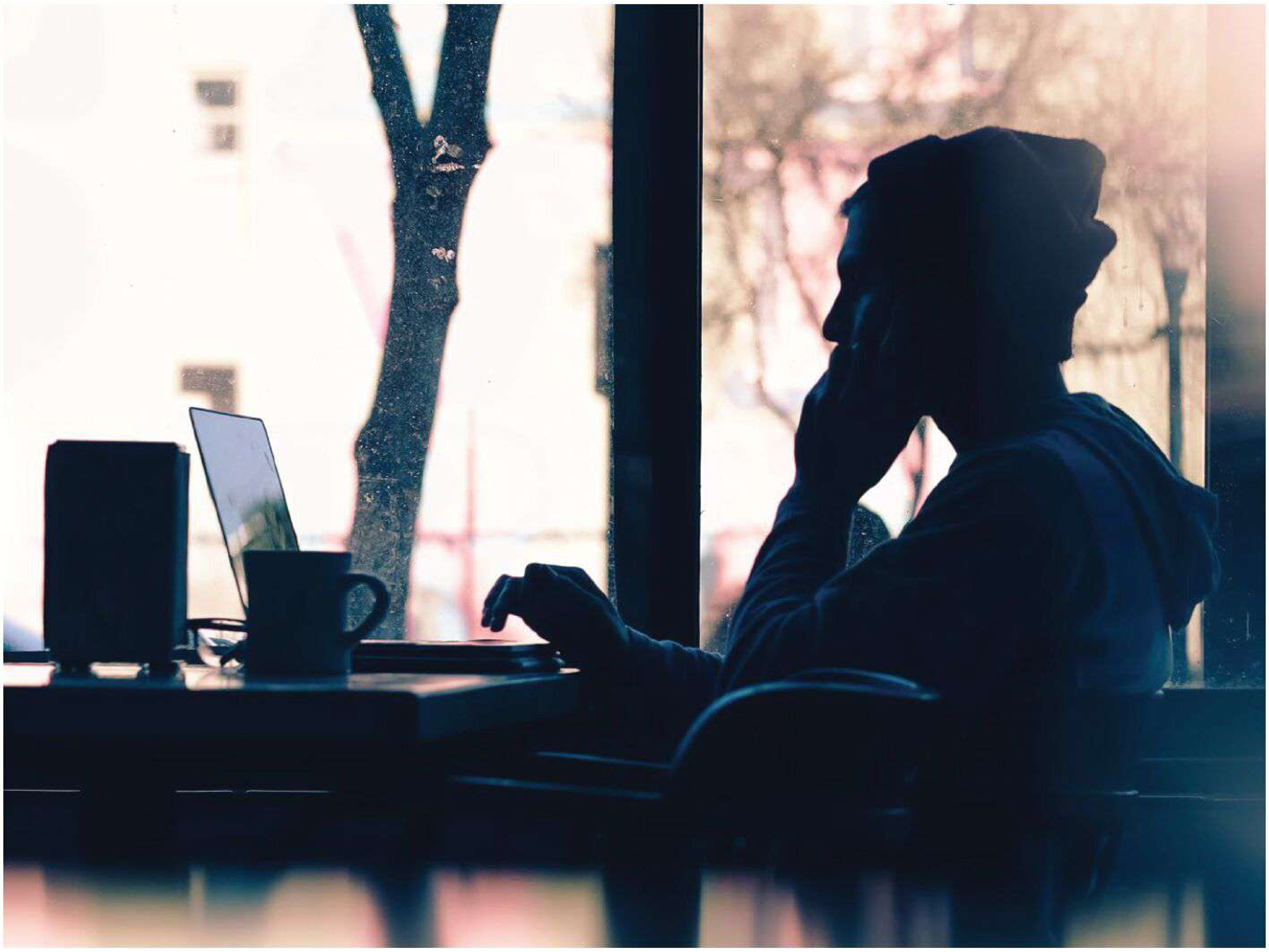
Intel said nothing about Meteor Lake, the eventual successor to Alder Lake. It did, however, close out its Intel Architecture Day with a message from its new chief executive, Pat Gelsinger, reminding everyone to attend Intel Innovation on late October. Could this be a launch party for Intel's Alder Lake laptops? We hope so.



Intel Thread Director can dynamically reallocate threads between the available performance and efficiency cores. Here, you see some high-priority (dark green) tasks running on the efficient cores, and some medium-priority tasks running on the performance cores. It's up to Thread Director to reassign these.

Unpatched Office attack reminds us: Don’t click on risky docs

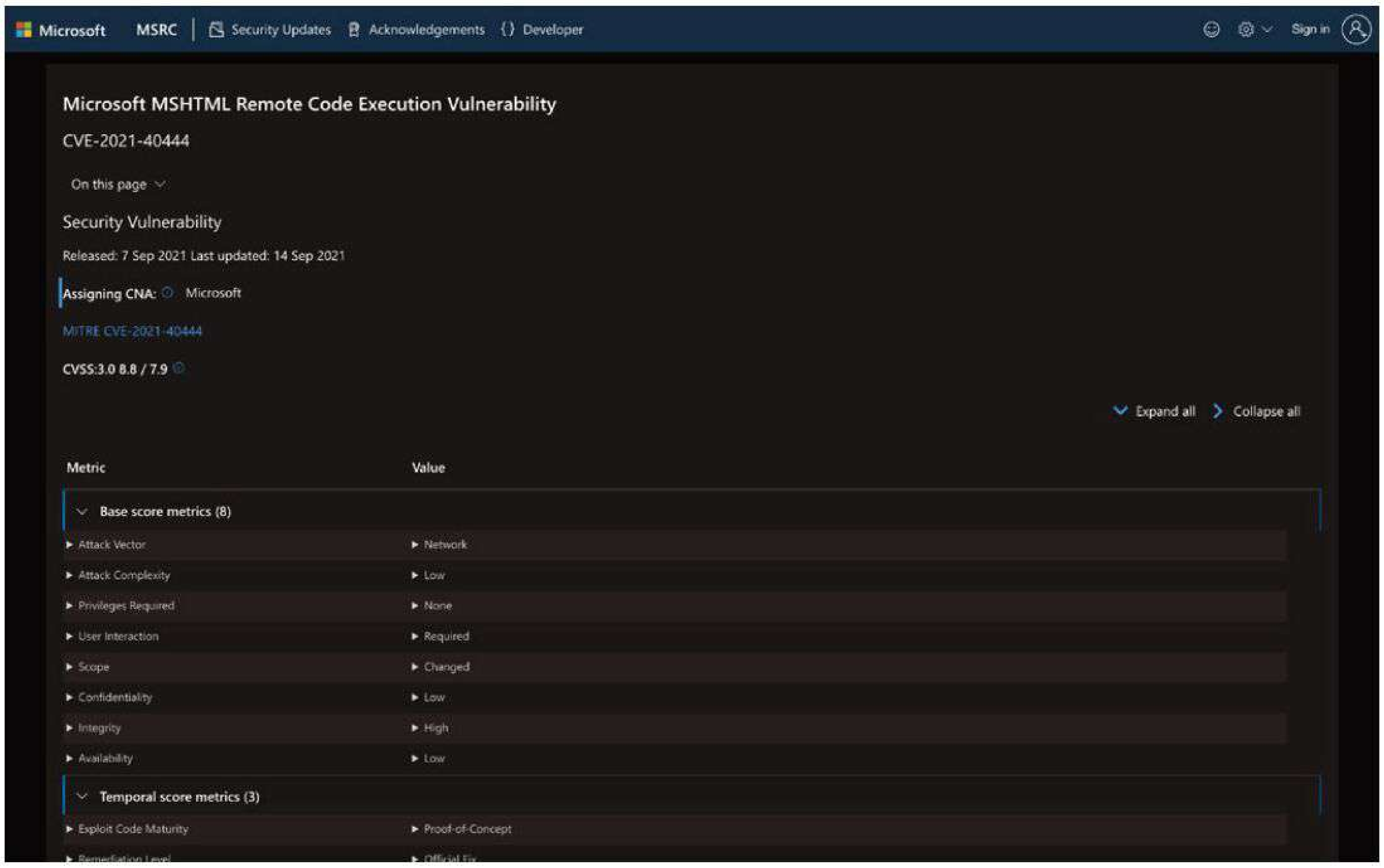
An attacker will have to convince you to click on the document as well as turn off Protected View. **BY MARK HACHMAN**



Microsoft is warning of a new Office vulnerability that is probably avoidable with smart Internet practices—namely, don’t open untrusted documents.

Researcher EXPMON reported a new vulnerability for Microsoft Office, the company said (go.pcworld.com/expm). Microsoft confirmed the vulnerability in a security update (go.pcworld.com/mcon). Microsoft has yet to issue a patch for it, although the company said it would “take the appropriate action to help protect our customers.”

IMAGE: HANNAH WEI/UNSPLASH



Microsoft MSHTML Remote Code Execution Vulnerability

CVE-2021-40444

Security Vulnerability

Released: 7 Sep 2021 Last updated: 14 Sep 2021

Assigning CNA: Microsoft

MITRE CVE-2021-40444

CVSS:3.0 8.8 / 7.9

Metric	Value
Base score metrics (8)	
Attack Vector	Network
Attack Complexity	Low
Privileges Required	None
User Interaction	Required
Scope	Changed
Confidentiality	Low
Integrity	High
Availability	Low
Temporal score metrics (3)	
Exploit Code Maturity	Proof-of-Concept
Remediation Level	Official Fix

Microsoft confirmed the vulnerability in a security update.

The vulnerability takes advantage of the MSHTML rendering engine used by Internet Explorer, a browser that Microsoft has deprecated. (IE will still run within Edge, but inside the browser's sandbox, which protects your PC.) So instead the attackers are targeting the IE engine running within Microsoft 365 or Office documents. If a malicious Office document is sent you via email, and you click on it or enable it, the vulnerability could be used to give an attacker control of your PC.

"An attacker could craft a malicious ActiveX control to be used by a Microsoft Office document that hosts the browser rendering engine," Microsoft said. "The attacker would then have to convince the user to open the malicious document. Users whose accounts are configured to have fewer user rights on the system could be less impacted than users who operate with administrative user rights."

Microsoft already has two layers of protection that will secure your PC against this threat. First, you first have to click on the malicious document to open it. Second, if your PC is configured—as it should be—to first open a document in Protected View (which prompts a "Be careful, this file originated" warning and confirms that you want to edit it), that vulnerability won't manifest. It's only if you click on the document and then turn off Protected View or Application Guard for Office that your PC could be at risk. So don't do that, OK?

Finally, Microsoft's last sentence drives home a key point—you might not be impacted as much if you're running as a standard user rather than with full admin rights. There's a reason we devoted a whole section to that very topic in our roundup of five easy tasks that can supercharge your security (go.pcworld.com/5tks).

How Windows 11 will speed up your slow PC

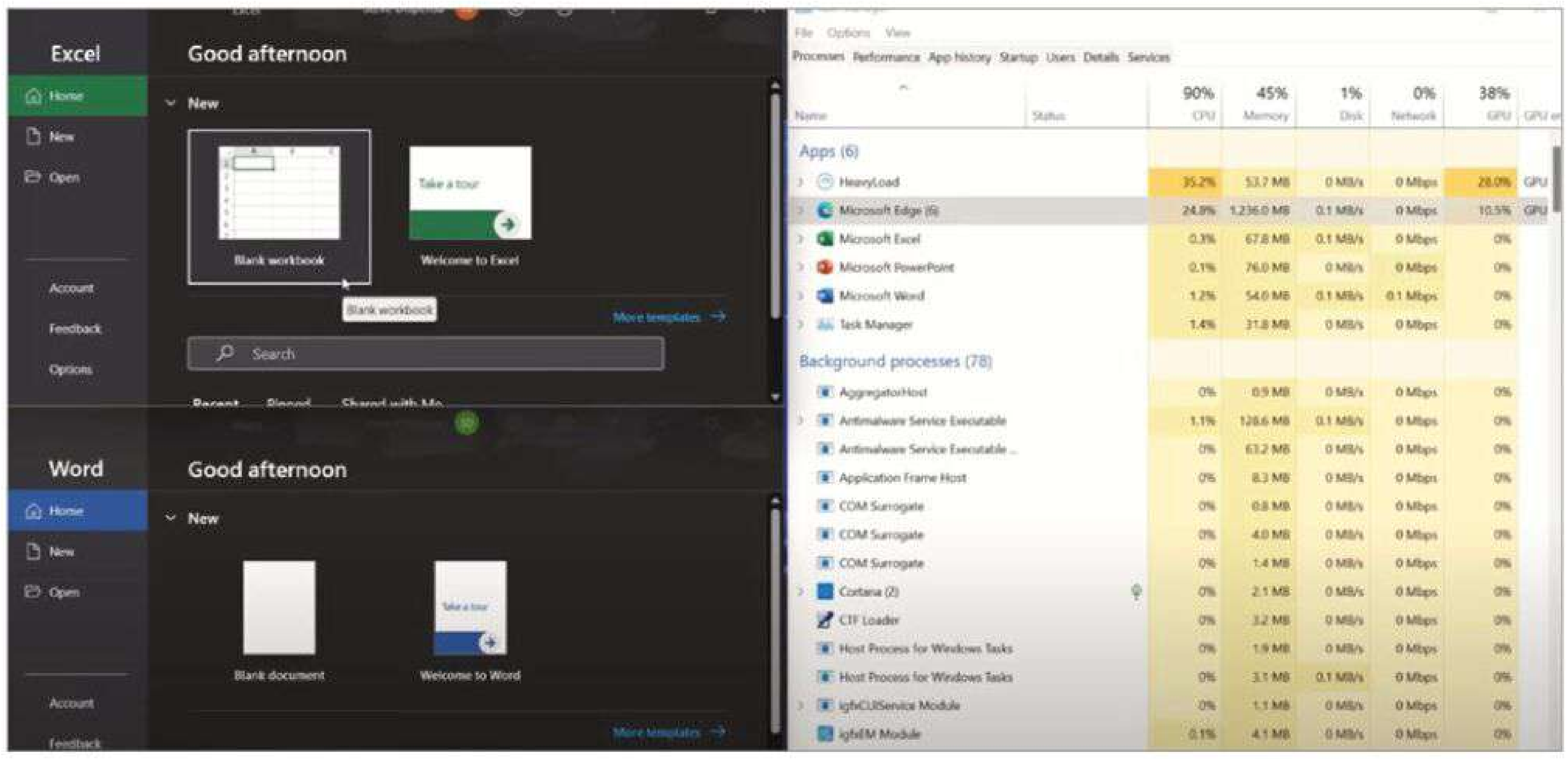
If your PC feels faster, is it faster? That's Windows 11's aim with some smart under-the-hood tweaks. **BY MARK HACHMAN**

Windows 11 (go.pcworld.com/wn11) sure looks different, but under-the-hood performance improvements may make it feel different, too—specifically in how the operating system handles multiple apps, as well as how your PC resumes from sleep. Microsoft detailed the changes in a video, where Steve Dispensa, vice president of enterprise management at Microsoft, explained how Windows 11 will deliver more performance in three different scenarios.

VIDEO: **WINDOWS 11: PERFORMANCE IMPROVEMENTS**

Watch now at go.pcworld.com/msv

IMAGE: OSCAR SUTTON/UNSPLASH


Excel
Good afternoon
New
Blank workbook
Welcome to Excel
Search
Word
Good afternoon
New
Blank document
Welcome to Word
Apps (6)
HeavyLoad
Microsoft Edge (6)
Microsoft Excel
Microsoft PowerPoint
Microsoft Word
Task Manager
Background processes (78)

In Microsoft's example, a PC already running a heavy load is asked to launch Word and Excel as well. Windows 11 allows that to happen without the user feeling like the PC is running slowly, Microsoft says.

RUNNING MULTIPLE APPS ON AN OVERLOADED PC

Take a PC with multiple applications running: email in the background, instant messaging, browsers with multiple tabs, and so on. A PC without much memory or CPU cycles available will run slowly, probably causing you to close an app or two to improve performance. In Windows 11, Microsoft promises that the way in which those apps are prioritized, called foreground prioritization, will make your PC feel faster even with a heavy load.

"Under the hood, we've done a lot of work in memory management to favor the apps running in the foreground so that they're prioritized with more CPU and other system resources," Dispensa said.

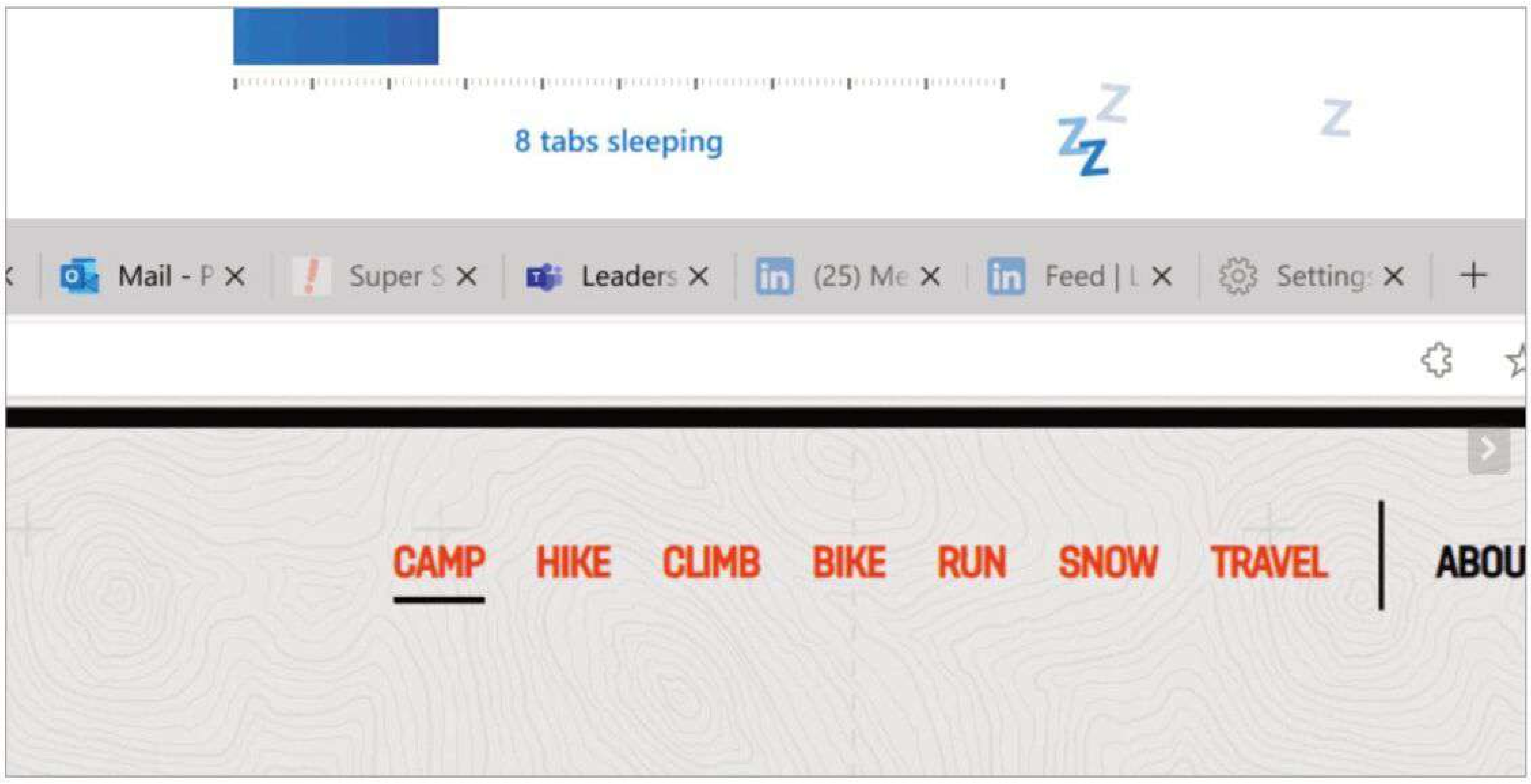
In the above scenario, Dispensa showed how a Windows 11 system could open Word and Excel, while leaving a synthetic "heavy CPU" application running in the background. What Windows 11 does is steal CPU cycles from that background application, slowing it down and allocating them to the apps you're using instead.

Dispensa said Windows 11 has reduced its storage footprint as well. For certain apps, like Sticky Notes, you won't even download the app as part of Windows 11. Instead, it will be stored as a "stub," and it will only be downloaded and installed as necessary.

RUNNING MULTIPLE EDGE TABS AT ONCE

In January, Microsoft first introduced the concept of "sleeping tabs" as part of Microsoft Edge 88 (go.pcworld.com/sltb). As the name suggests, a sleeping tab is rendered inactive, which frees up system resources for other tabs to use. In Windows 10 and within Edge, the sleeping tabs feature can be toggled on or off. Within the version of the Edge browser that ships with Windows 11, sleeping tabs will be turned on by default.

Within Windows 11, tabs will go to sleep after a set period of time—usually five minutes. By default, Edge will also "fade" sleeping tabs, so that they'll visually blend into the background while leaving the active tabs highlighted. Microsoft said originally that the sleeping tabs contributed to 32 percent less memory usage and 37 percent less CPU utilization. That should improve battery life as well, Dispensa said.



Microsoft first introduced the concept of "sleeping tabs" as part of Edge 88.

RESUMING FROM SLEEP

When you close your lid on your Windows 11 PC and it enters a sleep state, three things happen. First, your Windows 11 PC will keep your PC's memory in a low-power but active state, so that it powers up immediately. As you lift the lid, Windows is optimizing the software's "calls" to your PC's hardware to access them more quickly. Finally, the CPU's instruction threads are freeing up more resources to high-priority tasks too, Dispensa said.

"This approach optimizes resume from sleep by 25 percent," Dispensa said. "Most people, when they resume, will be almost instantaneous." Code optimizations have also resulted in up to 30 percent more performance in Windows Hello for Business logins as well, Dispensa added.

Want more? Watch Microsoft's full video (go.pcworld.com/msv).

Windows 11 PCs will keep your PC's memory in a low-power but active state, so that it powers up immediately.

Your big-screen laptop may be smaller than you think

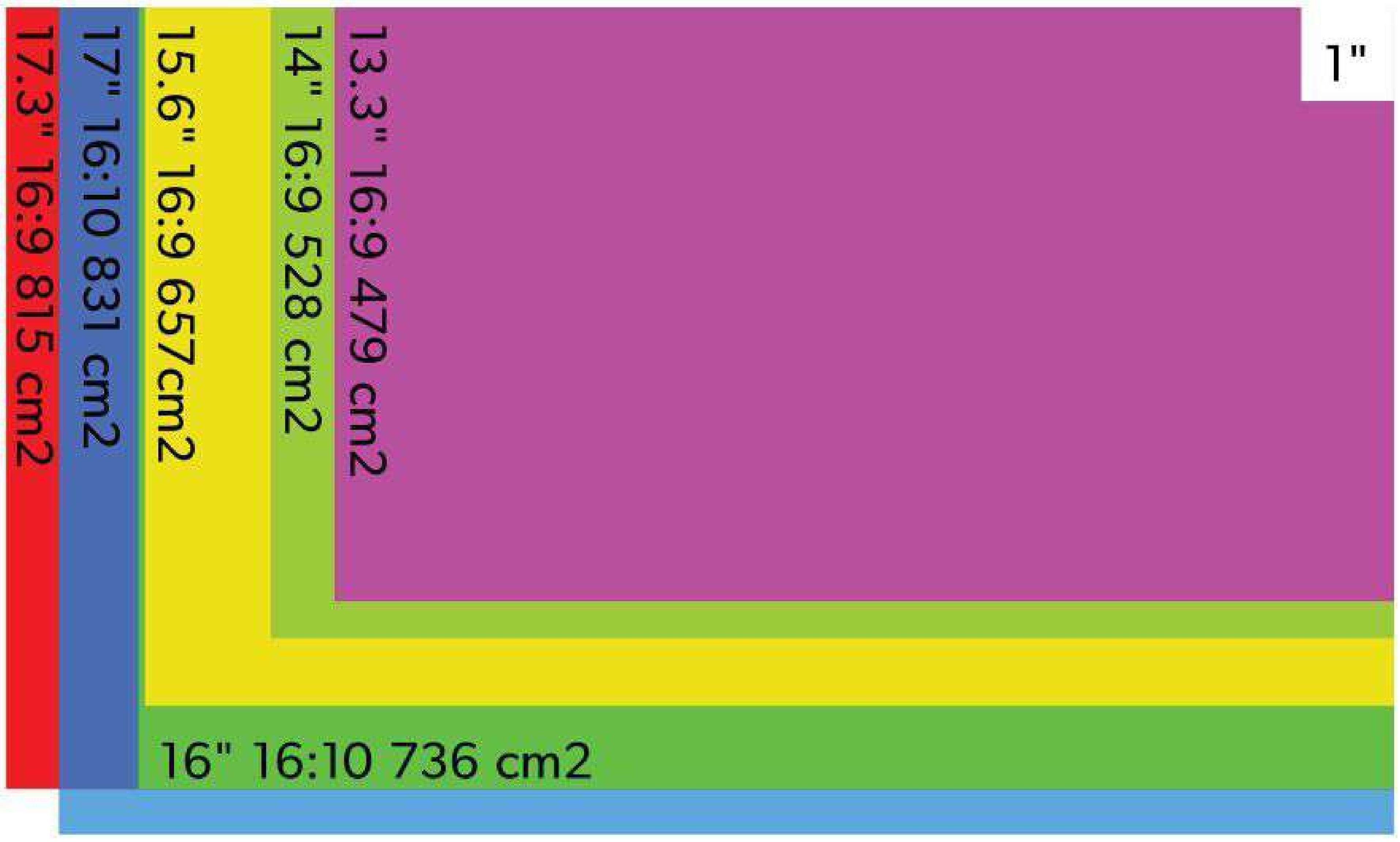
How we measure laptop screens needs to change. **BY GORDON MAH UNG**

In the world we live in, bigger is better. That, unfortunately, is how we got to a point where a 17.3-inch laptop screen isn't necessarily bigger than a 17-inch laptop screen.

And no, this isn't a fraction problem like the one that caused A&W to stop selling its one-third–pound burger (go.pcworld.com/3pnb) because people thought it was less than a quarter-pounder. Consumers legitimately expect a 17.3-inch laptop screen to be larger than a 17-inch one because 17.3 is bigger than 17. It's reasonable! But the key problem here is the differing aspect ratio of laptops. The vast majority of 17.3-inch laptops feature screens with an aspect ratio—the proportion between the length and the height of the panel—of 16:9, similar to what you see in HDTVs.

The Dell XPS 17's panel is 16:10 (see page 39). It's taller. That difference means its 17-inch screen offers just under 2 percent more screen real estate than a 17.3-inch 16:9 panel. That's not a lot, but the fact that the

IMAGE: DELL



It's time to ditch the diagonal measurement that makes people think a 17.3-inch panel is larger than a 17-inch panel.

average consumer will see 17 inches and think, "Well, I want the larger screen, so I'll go for the 17.3-inch laptop" means that measurement does a disservice to buyers.

Why do we even bother to measure laptop screens using a method dreamed up 70 years ago for TVs? Internet urban legend claims TV makers didn't want to explain the length and width of the screen, and using the diagonal measurement gave them a "bigger number to market."

Yes, that means we're still using a standard that was developed to fool consumers into thinking a 26-inch wood console TV was bigger. What's worse: The diagonal measurement doesn't even provide a bigger number to sell.

For this story, I physically measured the length and width of multiple laptops because most panels are typically a millimeter or so smaller than what the vertical measurement would have you believe. I apologize for pulling a NASA (go.pcworld.com/plns) and mixing U.S. customary units and the metric system, but the smaller units in the metric system make it easier to discuss.

Still, the most common panel in an ultralight laptop is a 13.3-inch 16:9 screen. On an HP Elite Dragonfly I measured, that works out to 29.2 cm wide by 16.4 cm tall, or 479 cm^2 in total area (go.pcworld.com/

The most common panel in an ultralight laptop is a 13.3-inch 16:9 screen, such as the one used in HP's Elite Dragonfly.

hpdg). These laptops typically bump right up against 14-inch laptops using the same 16:9 aspect ratio, such as the MSI Prestige 14 Evo (go.pcworld.com/msi4), which I measured at 30.7cm wide and 17.2cm tall.

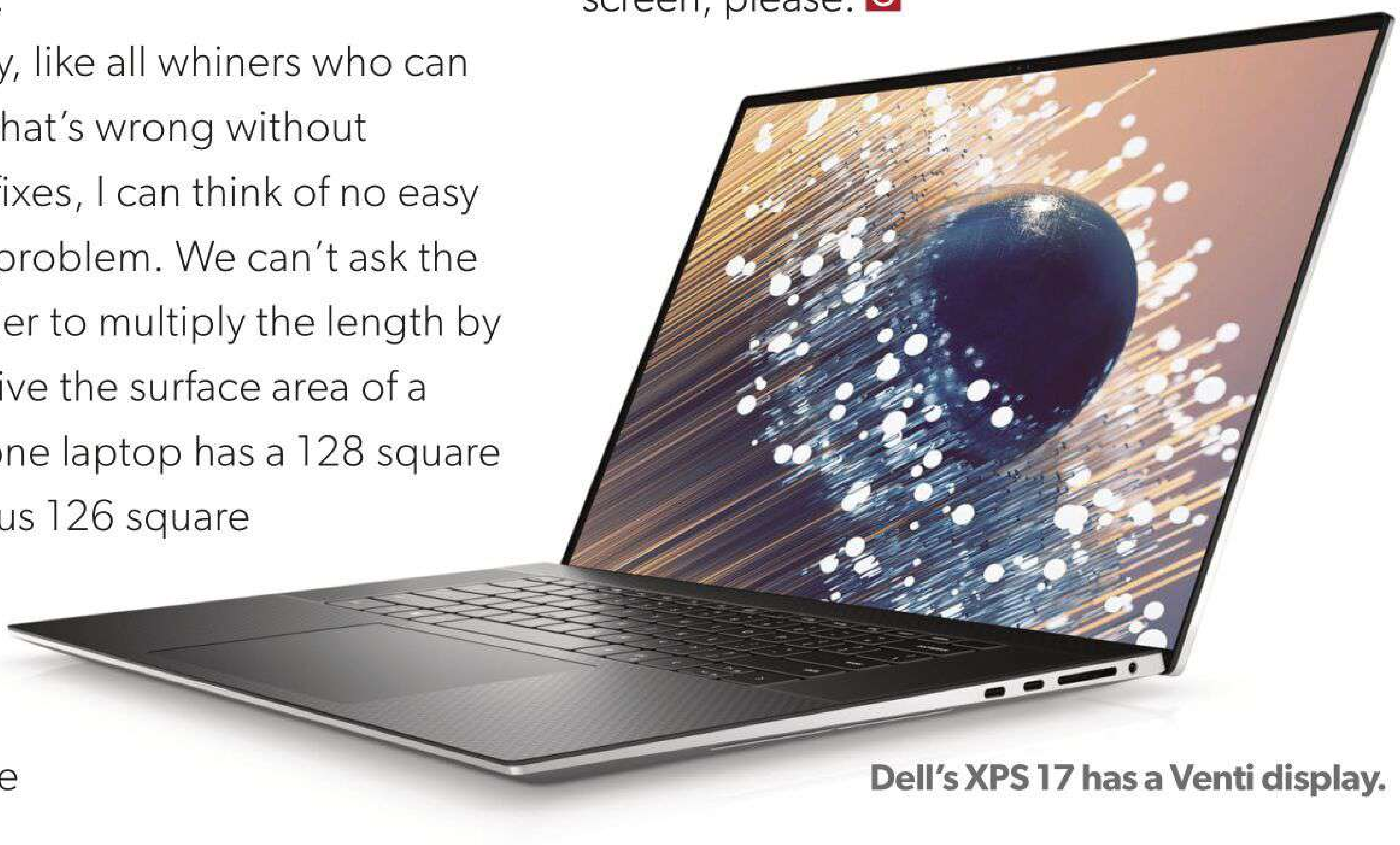
On the face of it, 0.7 inches is no big deal, right? That's only about a 5 percent larger screen. But if you work out the actual surface area, the 14-inch laptop actually offers you 10.2 percent more area than the 13.3-inch laptop.

You'd probably say the same thing about laptops using the new crop of 16-inch panels that are popping up, such as the MSI Creator Z16 (go.pcworld.com/mz16). It's really only 0.4 inches more than the 15.6-inch panel in the Asus ROG Strix M16 (go.pcworld.com/as16)—just 2.5 percent—so again, not a big deal, right? In *actual* screen real estate, though, it's closer to 12.1 percent larger, or 80cm^2 of total area. Heck, that's practically an Apple Touch Bar.

Unfortunately, like all whiners who can only point out what's wrong without suggesting any fixes, I can think of no easy way to cure the problem. We can't ask the average consumer to multiply the length by the width to derive the surface area of a screen. Saying one laptop has a 128 square inch screen versus 126 square inches probably doesn't help either. Maybe we should adopt some accepted arbitrary but standardized measurement, like we do for beds: king, queen, full, and twin. That leaves room for such things as a California king (yes, it's a real thing) and the screen real estate is baked into the consumer's expectation of size.

Starbucks uses an arbitrary size for its coffee cups that we could adopt. You have no idea how large that $6 Grande is, but you know it's bigger than a Venti. Oh, wait, maybe I have that backward—but you get the idea.

Consumers expect laptops with a *larger* stated screen size to be larger, but with 16:9, 16:10, and even 3:2 panels of all different dimensions and sizes, it's time to find a more accurate means of measurement—even if it's something arbitrary that people can actually understand. So gimme that Dell XPS 17 with a Venti screen, please.



Dell's XPS 17 has a Venti display.

8 new Windows 11 features we didn't expect

It appears Windows 11 will have a lot to offer when it ships late this year. **BY BRAD CHACOS**

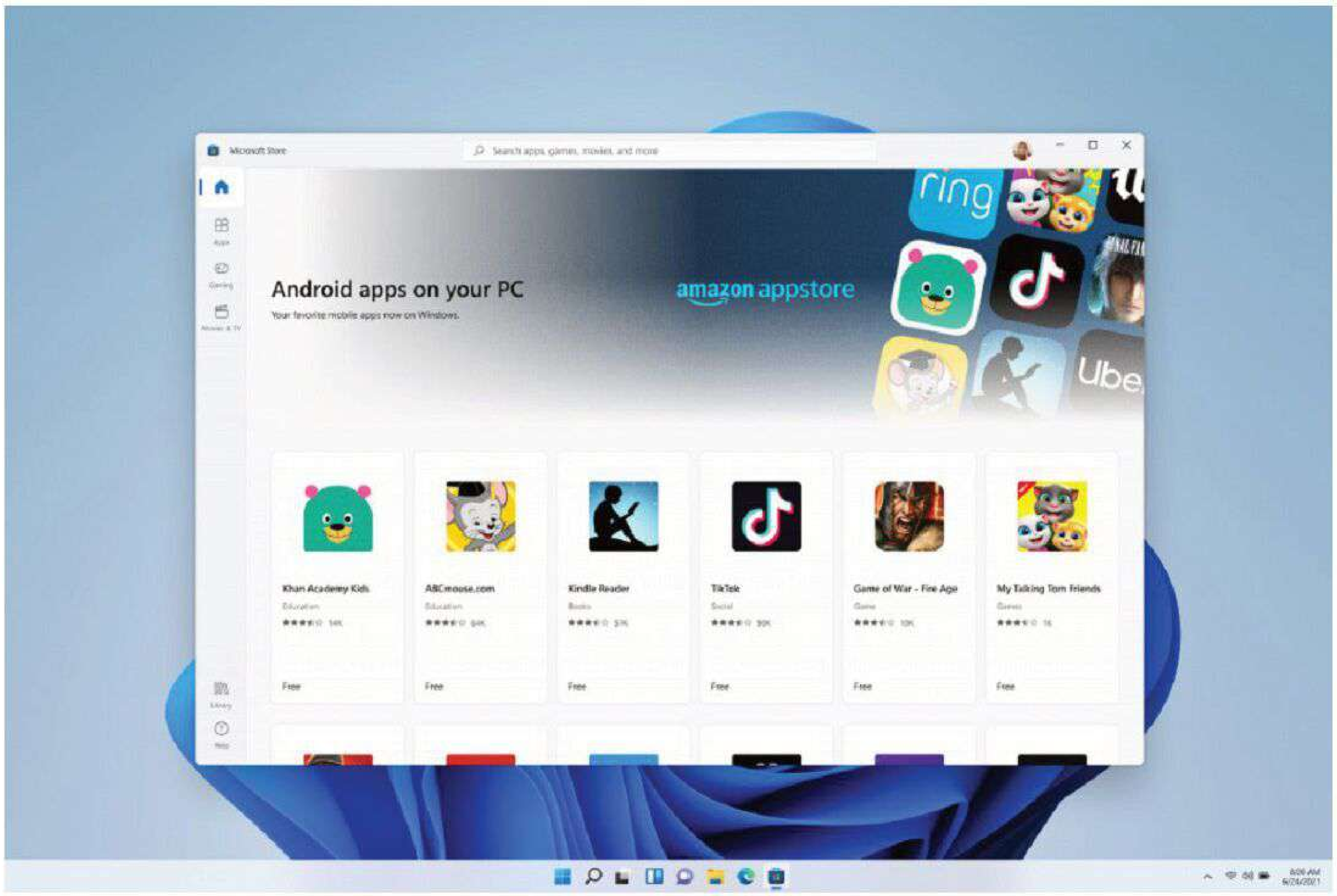
Windows 11 is almost here, complete with a new look, a new location for your taskbar icons, and a new (and stringent) list of hardware requirements (go.pcworld.com/btsp). But a fresh coat of paint is essentially mandatory with a new version of Windows. What we *didn't* anticipate was the laundry list of features coming with the new operating system, many of them surprising.

From Android apps to automatic HDR in games to the glorious return of widgets, here are 7 new Windows 11 features we didn't expect. You'll be able to try them out for yourself when the operating system launches on October 5 (see page 7).

1. ANDROID APPS ON YOUR WINDOWS 11 PC

Microsoft chief product officer Panos Panay said that he was "pumped" to bring Android apps to the PC, and why wouldn't he be? Android apps have been one of the advantages of Google's Chrome OS platform

IMAGE: MICROSOFT


Microsoft Store
Search apps, games, movies, and more
Apps
Gaming
Movies & TV
amazon appstore
ring
Uber
Khan Academy Kids
Education
ABCmouse.com
Education
Kindle Reader
Books
TikTok
Social
Game of War - Fire Age
Game
My Talking Tom Friends
Games
Free
Library
Help

Android apps on your PC

Your favorite mobile apps now on Windows.

Android apps will arrive on Windows 11, but it's not clear how many of them Windows 11 will include.

(go.pcworld.com/chos), which powers competing Chromebooks. Their addition to Windows 11 means that the number of apps available to Windows PCs will grow potentially much larger. Microsoft doesn't frequently break out the number of Windows apps, but in 2018 Microsoft revealed that there were 35 million Windows-capable apps, including legacy software (go.pcworld.com/18re). AppBrain puts the number of Android apps (go.pcworld.com/anap) at about 3 million.

It's not clear whether Microsoft will bring every Android app to the PC, as they'll appear in the Microsoft Store, not a version of the Google Play Store for the PC. And in fact, it'll be Amazon's Android app store powering things behind the scenes. Microsoft showed off Khan Academy, Kindle Reader, TikTok, and more in an example screenshot.

To bring Android apps to Windows PCs, Microsoft is using the Intel Bridge technology (go.pcworld.com/ibrd), which Intel describes on a high level as a "runtime post-compiler that enables applications to run natively on x86-based devices, including running those applications on Windows."

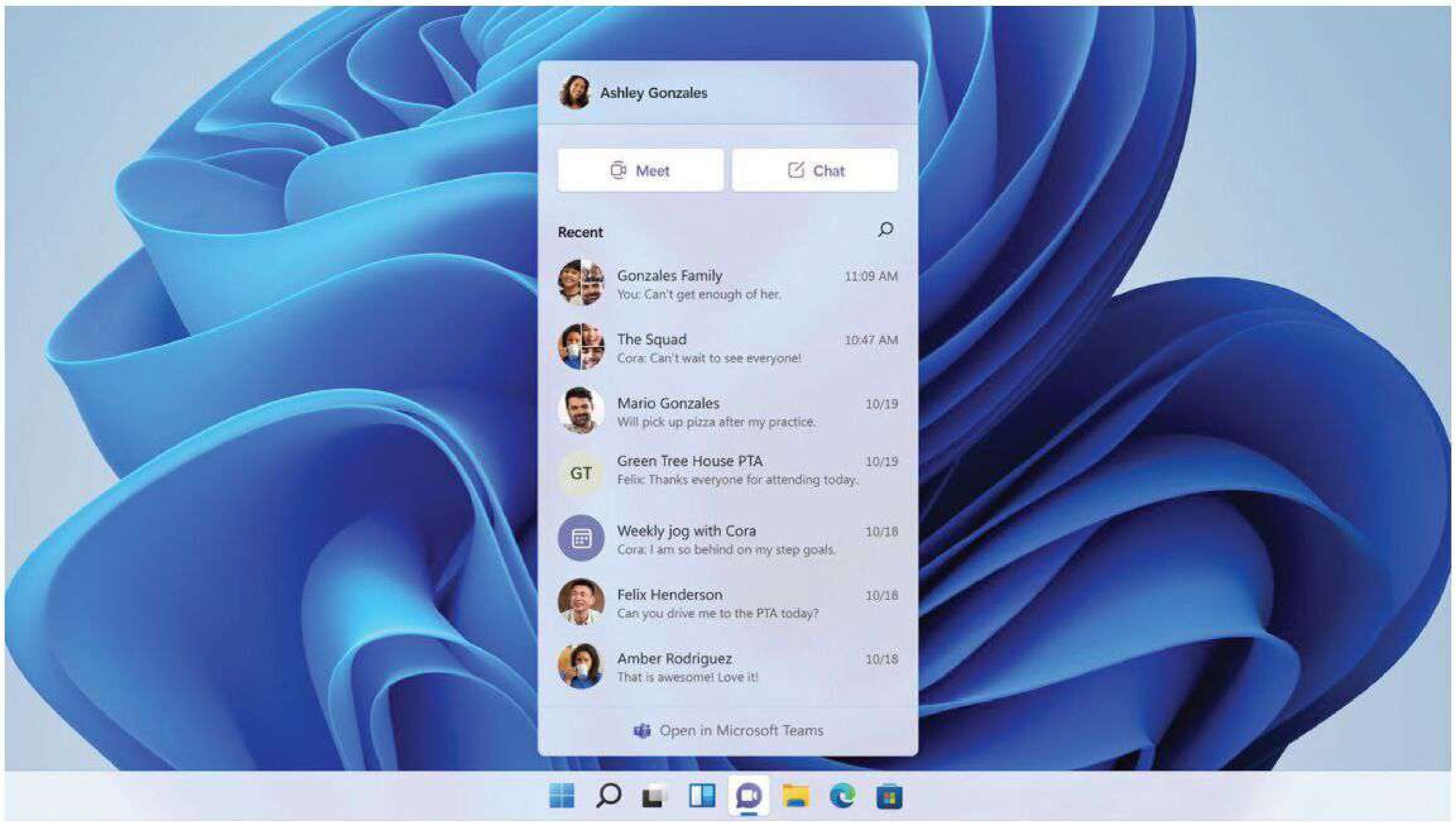
It sounds like Windows 11 will be performing that work on your PC rather than on the Microsoft Store, so that Windows 11 PCs should be able to sideload Android apps and games—eventually, at least. Shortly ahead of Windows 11's launch, Microsoft announced that Android apps won't be available on day one (go.pcworld.com/avd1).

2. TEAMS CHAT IN YOUR TASKBAR

Like it or not, Microsoft insists that you be able to reach contacts easily from your

Windows desktop. It began with the now-defunct (go.pcworld.com/klpa) People app (go.pcworld.com/peap), then moved to Skype Meet Now in your Taskbar (go.pcworld.com/mtnw), too. Now it's moving on to Teams, putting Teams Chat into your Windows 11 taskbar.

"With Windows 11, we're excited to introduce Chat from Microsoft Teams integrated in the taskbar," Microsoft said in a blog post introducing Windows 11 (go.pcworld.com/iw11). "Now you can instantly connect through text, chat, voice or video with all of your personal contacts, anywhere, no matter the platform or device they're on, across Windows, Android or iOS. If the person you're connecting to on the other end hasn't downloaded the Teams app, you can still connect with them via two-way SMS."



Gonzales Family 11:09 AM
You: Can't get enough of her.

The Squad 10:47 AM
Cora: Can't wait to see everyone!

Mario Gonzales 10/19
Will pick up pizza after my practice.

GT Green Tree House PTA 10/19
Felix: Thanks everyone for attending today.

Weekly jog with Cora 10/18
Cora: I am so behind on my step goals.

Felix Henderson 10/18
Can you drive me to the PTA today?

Amber Rodriguez 10/18
That is awesome! Love it!

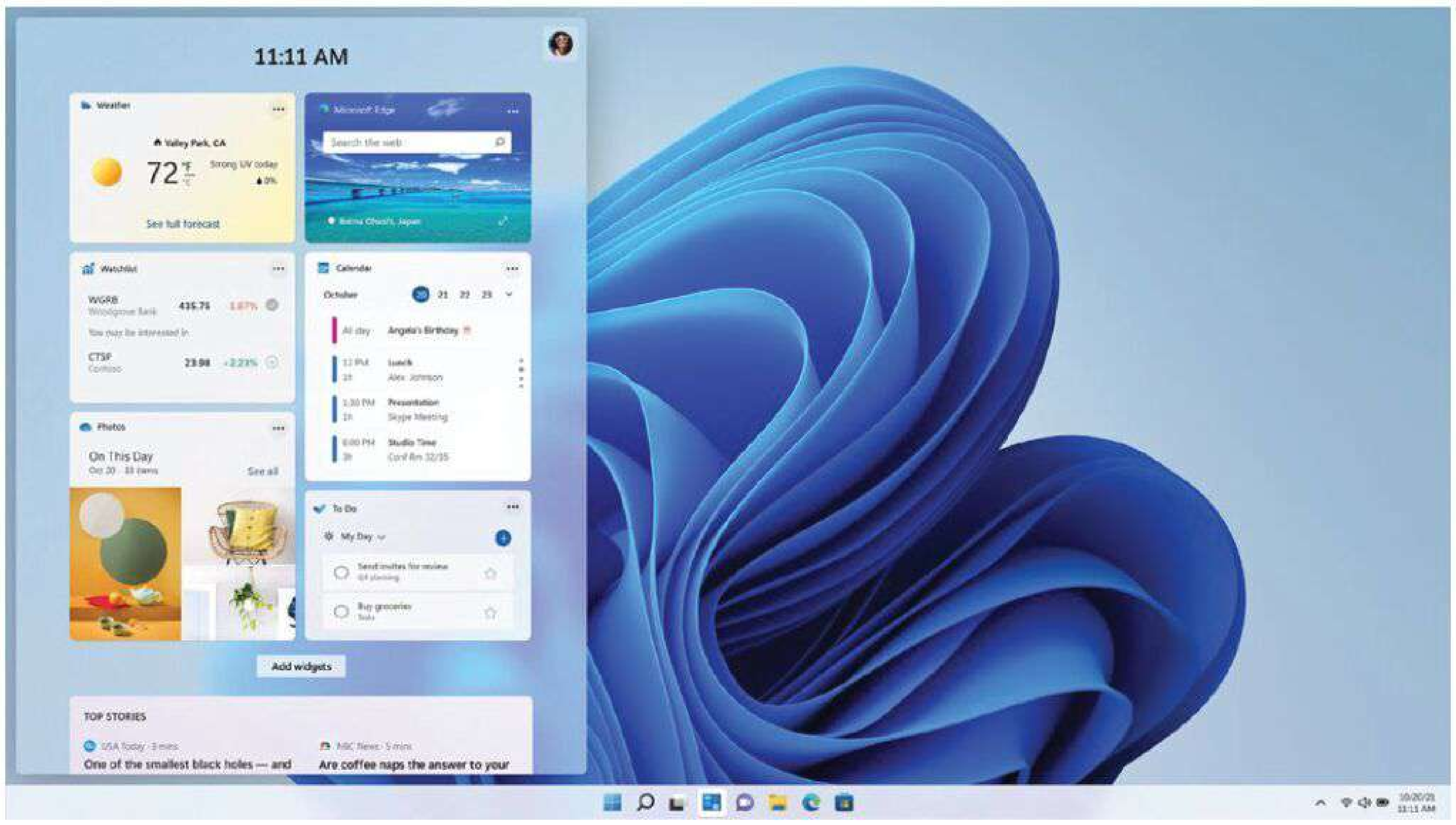
Microsoft is adding Teams Chat to the Taskbar.

You'll also be able to instantly mute and unmute people right from the taskbar, and even start presenting during a Teams call.

3. WELCOME TO WIDGETS

We glimpsed Widgets briefly in our Windows 11 hands-on (go.pcworld.com/11ho), but there's clearly more to it based on Microsoft's official presentation. Right now, Widgets is a ginormous card that slides out from the left side of your desktop. It appears to be a combination of Windows 10's News & Interests (go.pcworld.com/nwin), Your Phone, and more, with news, notifications, and personalized information of various types being pushed to your PC.

Will there be specialized widget apps? It sounds like there could be. There's even an interesting feature that Microsoft embedded into the livestream describing the new Widgets feature (noticed by the Verge): the ability to tip local content creators (go.pcworld.com/wdft). "Our aspiration is to create a vibrant pipeline for global brands


11:11 AM
Weather
Valley Park, CA
72°F
See full forecast
Watchlist
Calendar
October
Photos
On This Day
To Do
My Day
Add widgets
TOP STORIES

What will Windows 11 Widgets look like in a year's time?

and local creators alike, in a way that both consumers and creators can benefit," Microsoft said.

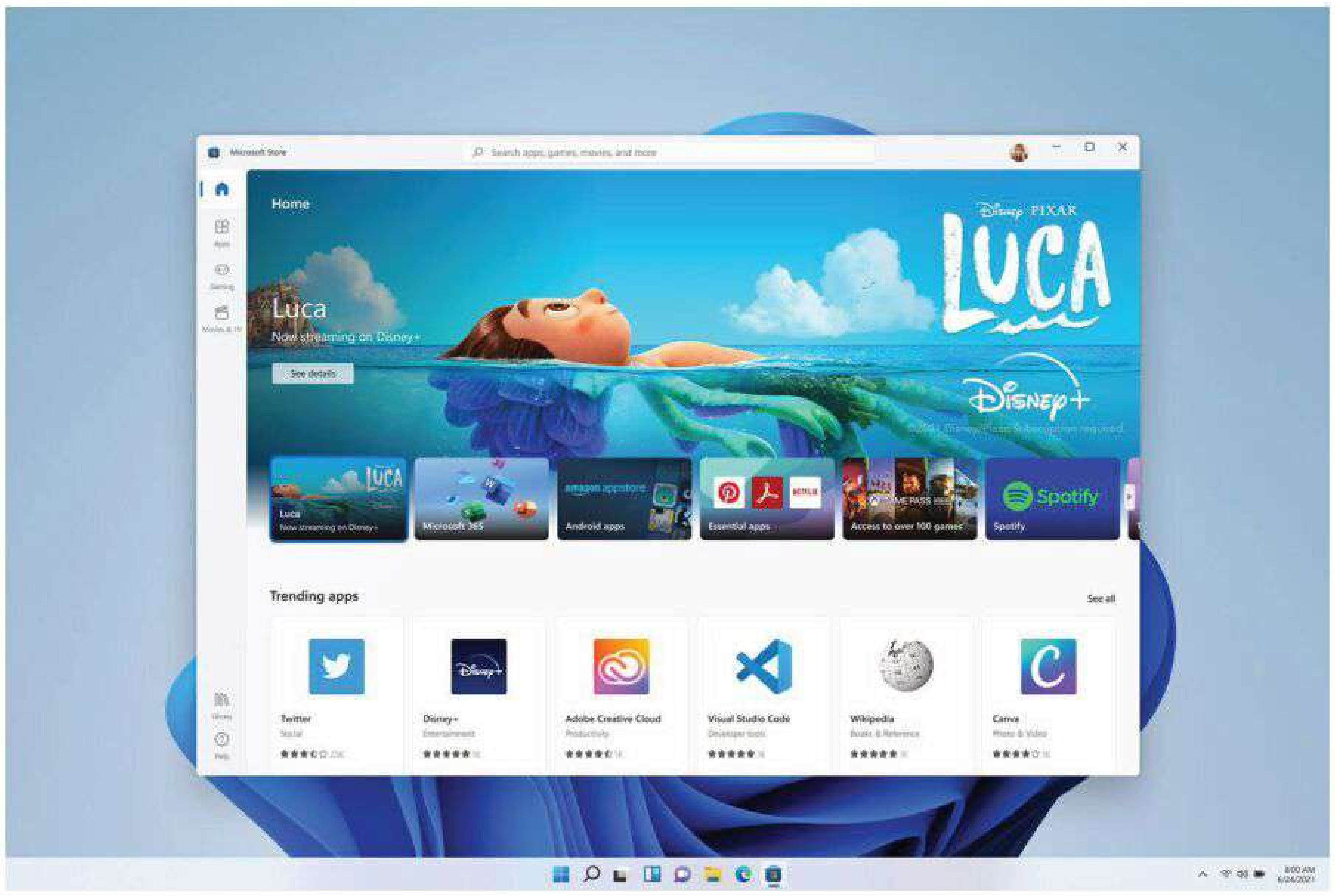
4. AN UPGRADED MICROSOFT STORE

Stop us if you've heard this before: The Windows Store needs a makeover (go.pcworld.com/movr). Not only is there back-end functionality that could stand to be improved, but the ability to find new apps isn't as good as it could be.

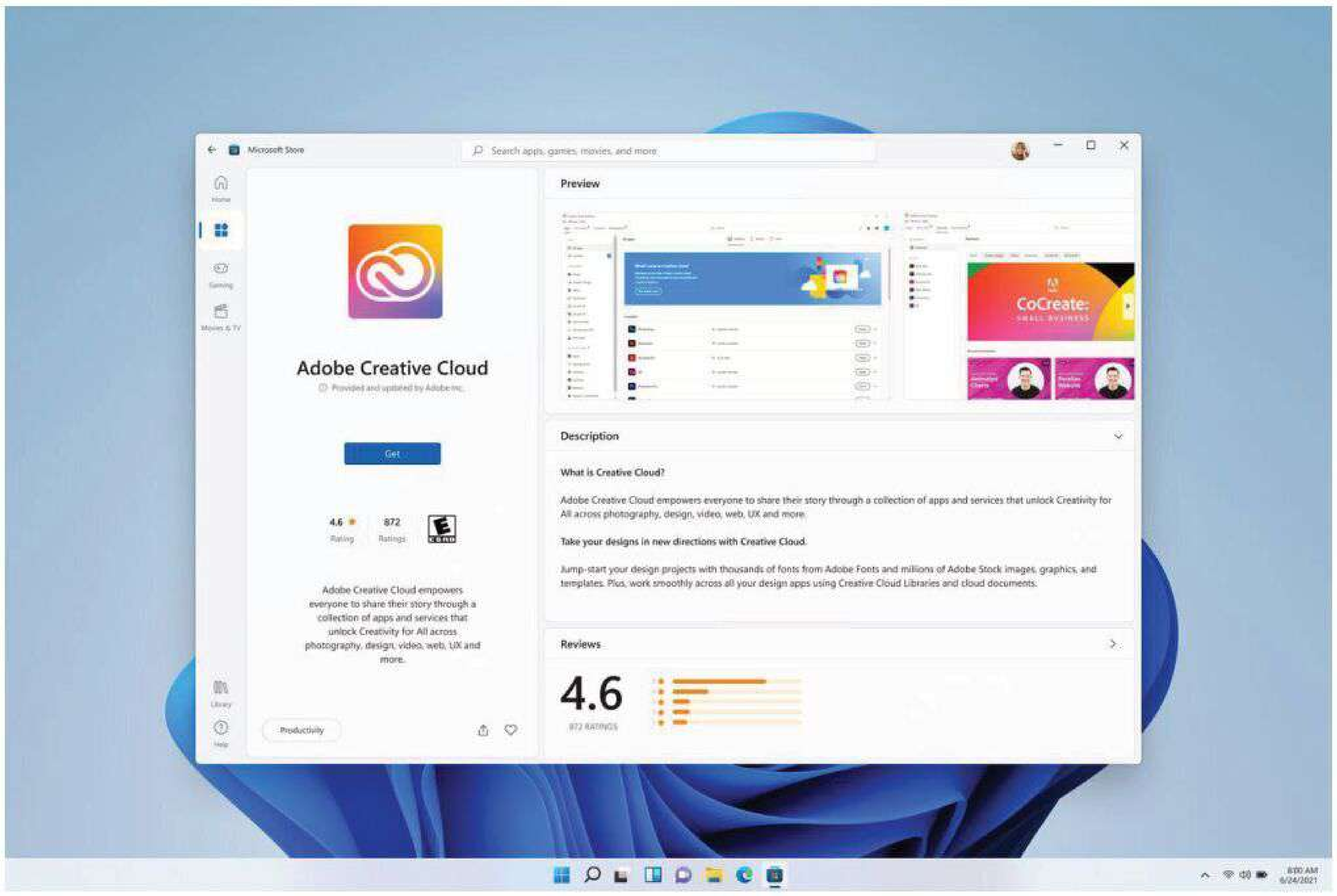
Microsoft plans to upgrade the Store—though it's not saying when—with a new user interface and greater curation. "Not only will we bring you more apps than ever before, we're also making all content—apps, games, shows, movies—easier to search for and discover with curated stories and collections," the company says.

Microsoft is bringing more apps to the Store, including some of its own apps that have never made an appearance there up to now, such as Microsoft Teams and Visual Studio. It's also adding key third-party apps, such as Disney+, Adobe Creative Cloud, Zoom, and Canva.

We just hope that we can somehow store an app we've downloaded without the need to redownload it every time we want to add it to a new PC.


Microsoft Store
Home
Luca
Now streaming on Disney+
See details
LUCA
Disney+
Microsoft 365
Android apps
Essential apps
Access to over 100 games
Spotify
Trending apps
See all
Twitter
Disney+
Adobe Creative Cloud
Visual Studio Code
Wikipedia
Canva

This is the updated look for the Microsoft Store app.


Microsoft Store
Search apps, games, movies, and more
Home
Gaming
Movies & TV
Library
Help
Adobe Creative Cloud
Provided and updated by Adobe Inc.
Get
4.6
Rating
872
Ratings
Productivity
Preview
CoCreate:
SMALL BUSINESS
Description
Reviews
4.6
872 RATINGS

Adobe Creative Cloud empowers everyone to share their story through a collection of apps and services that unlock Creativity for All across photography, design, video, web, UX and more.

What is Creative Cloud?

Adobe Creative Cloud empowers everyone to share their story through a collection of apps and services that unlock Creativity for All across photography, design, video, web, UX and more.

Take your designs in new directions with Creative Cloud.

Jump-start your design projects with thousands of fonts from Adobe Fonts and millions of Adobe Stock images, graphics, and templates. Plus, work smoothly across all your design apps using Creative Cloud Libraries and cloud documents.

The individual app pages are receiving an overhaul, too.

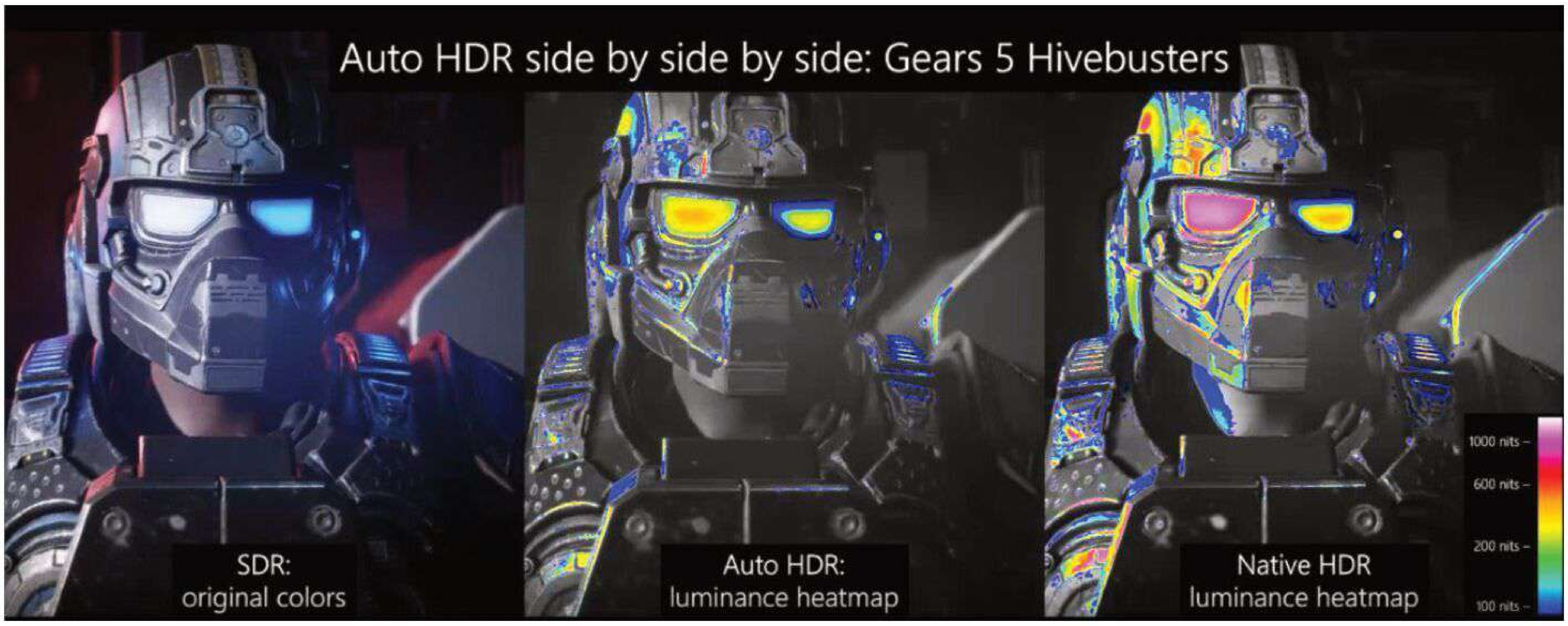
5. FASTER WINDOWS UPDATES

Some people really, really hate Windows updates—enough so that we added a how-to story to help you manage your Windows updates (go.pcworld.com/updt).

Microsoft is promising to help improve Windows updates by making them smaller and faster, presumably making them less obtrusive as well. Historically, Microsoft has accomplished this by “knowing” exactly what code your PC has and then delivering exactly what it needs.

6. DIRECTSTORAGE & AUTO HDR COME TO WINDOWS

Microsoft has said previously that DirectStorage, the storage backbone of the Xbox Series X (go.pcworld.com/xbsr), would be coming to PCs —it just didn’t say


Auto HDR side by side by side: Gears 5 Hivebusters
SDR:
original colors
Auto HDR:
luminance heatmap
Native HDR
luminance heatmap
1000 nits –
600 nits –
200 nits –
100 nits –

Microsoft shows off how it handles luminance in a PC game when enabled with HDR. It won’t be quite as good as native HDR, but it will be close.

Microsoft has announced voice dictation, with punctuation algorithmically applied.

when. Now we know it will arrive as part of Windows 11.

DirectStorage is a Windows API that will be used to control what Microsoft calls the Xbox Velocity Architecture. It's Microsoft's approach to reducing the storage capacity that an Xbox Series X game requires, loading the game and its assets as quickly as possible. Now it's coming to Windows.

If you've recently read our excellent explainer on what HDR is and how to enable it in Windows 10 (go.pcworld.com/nhdr), you have a head start on what this means for Windows 11: AutoHDR is coming for Windows games. "When enabled on your HDR capable gaming PC, you will automatically get awesome HDR visuals on an additional 1000+ DirectX 11 and DirectX 12 games!" Hannah Fisher, a program manager with Microsoft, noted in a recent blog post explaining the new feature (go.pcworld.com/xnft).

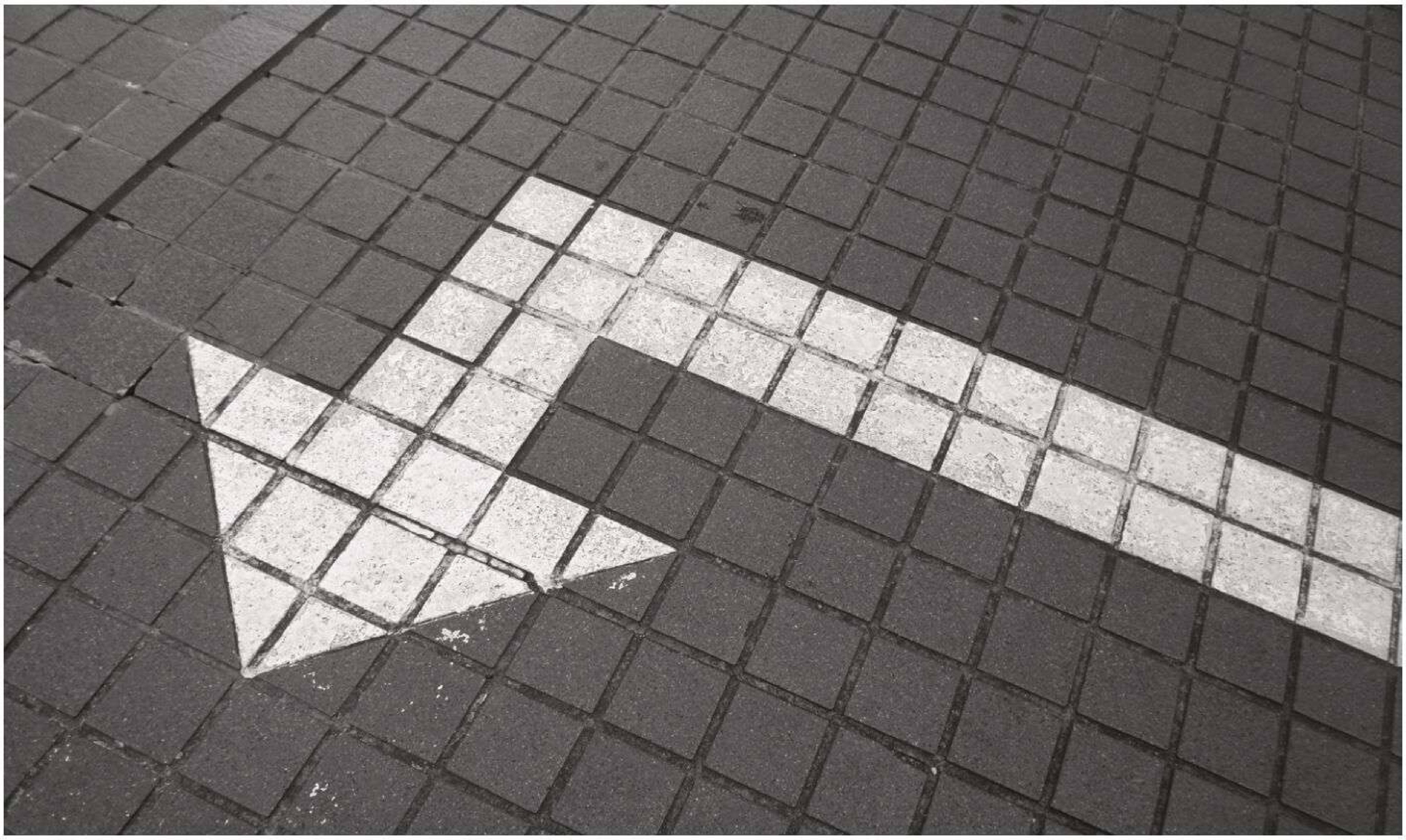
Did we expect AutoHDR sometime on PCs? Sure. But it's being released in conjunction with Windows 11, which is pretty cool.

7. WINDOWS 11 S IS A THING

Microsoft's simplified Windows 10 S operating system never got much respect—we published instructions on how to switch to Windows 10 Home or Pro instead (go.pcworld.com/hpro). Microsoft's Windows 10X was originally designed to be even simpler as a direct challenge to Chromebooks and a possible replacement for Windows 10 S. But having cancelled Windows 10X entirely (go.pcworld.com/c10x), Microsoft is moving ahead with a simplified Windows 11 Home in S Mode.

8. VOICE TYPING WITH PUNCTUATION

We're sneaking in an eighth feature that Microsoft quietly announced: voice dictation, but with punctuation algorithmically applied. Dictation is always one of those things that's a bit tricky, but if you can pull it off then it can save gobs of time. (Try it out yourself in Windows 10 by typing **WIN+H**.)



Beware this new phishing attack that's after your passwords!

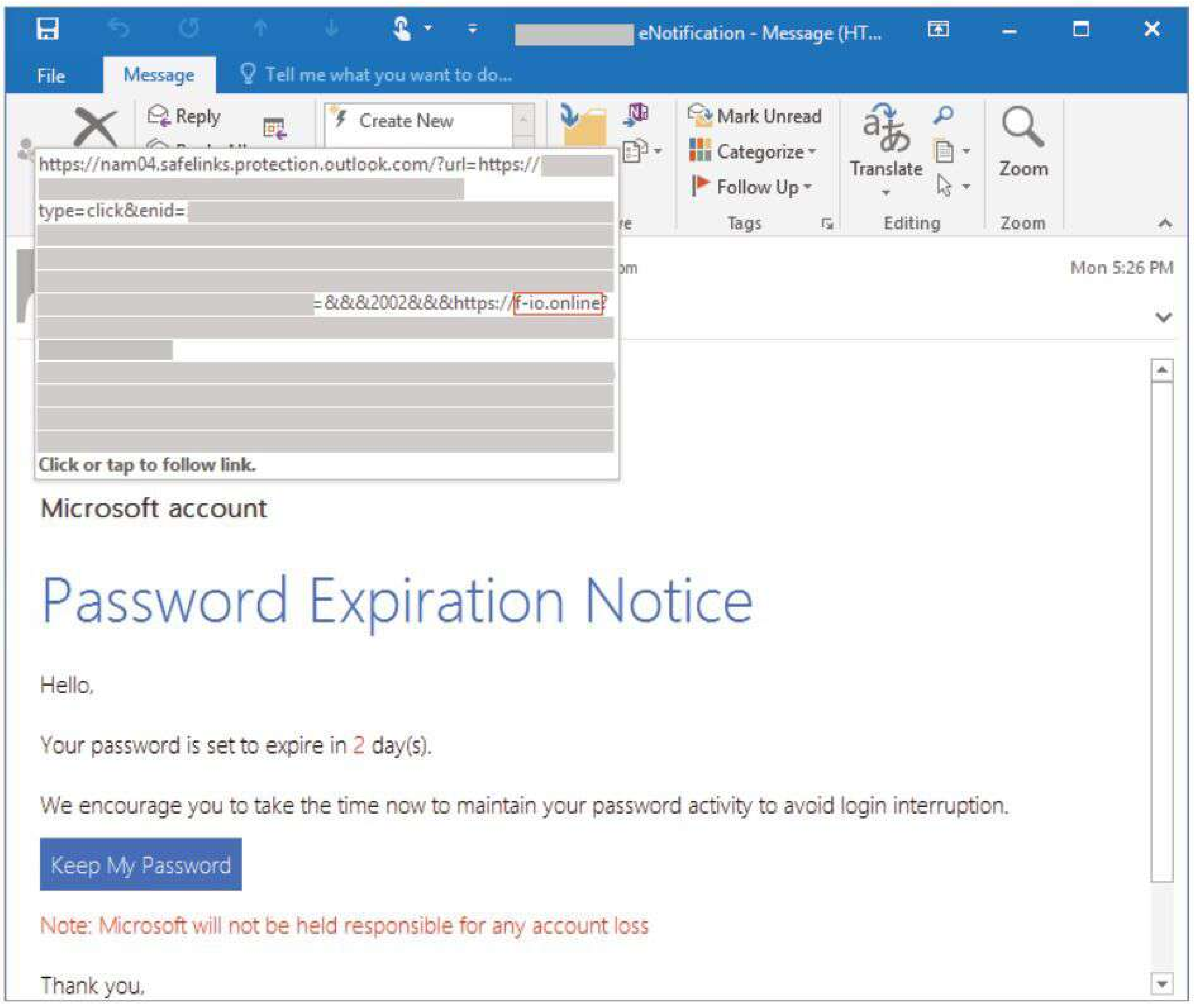
That email link might not send you where you expect. **BY ALAINA YEE**

A classic bit of internet security advice just bit the dust. For ages, email users were told to hover their mouse over a link to see where it led—if you saw the URL of a legitimate website, you were in the clear. But on Tuesday, Microsoft shared details on a kind of phishing attack it's seeing more frequently: Email with links that contain a known website at the start, but actually redirect to a malicious page.

This ploy relies on a type of link often used by sales and marketing teams to track information about who clicks on a URL in a newsletter or on social media. Known as open redirect links, the structure of the link begins with a primary domain, then includes a string of analytics data and a final destination site.

But as Microsoft describes in a post on its security blog (go.pcworld.com/phcm), this phishing strategy uses open redirect links to exploit an average end user's security training.

IMAGE: UNSPLASH


eNotification - Message (HT...
File
Message
Tell me what you want to do...
Reply
Create New
Mark Unread
Categorize
Follow Up
Tags
Translate
Editing
Zoom
Zoom
Mon 5:26 PM

https://nam04.safelinks.protection.outlook.com/?url=https://[redacted]

type=click&enid=[redacted]

[redacted]=&&&2002&&&https://f-io.online[redacted]

Click or tap to follow link.

Microsoft account

Password Expiration Notice

Hello,

Your password is set to expire in 2 day(s).

We encourage you to take the time now to maintain your password activity to avoid login interruption.

Keep My Password

Note: Microsoft will not be held responsible for any account loss

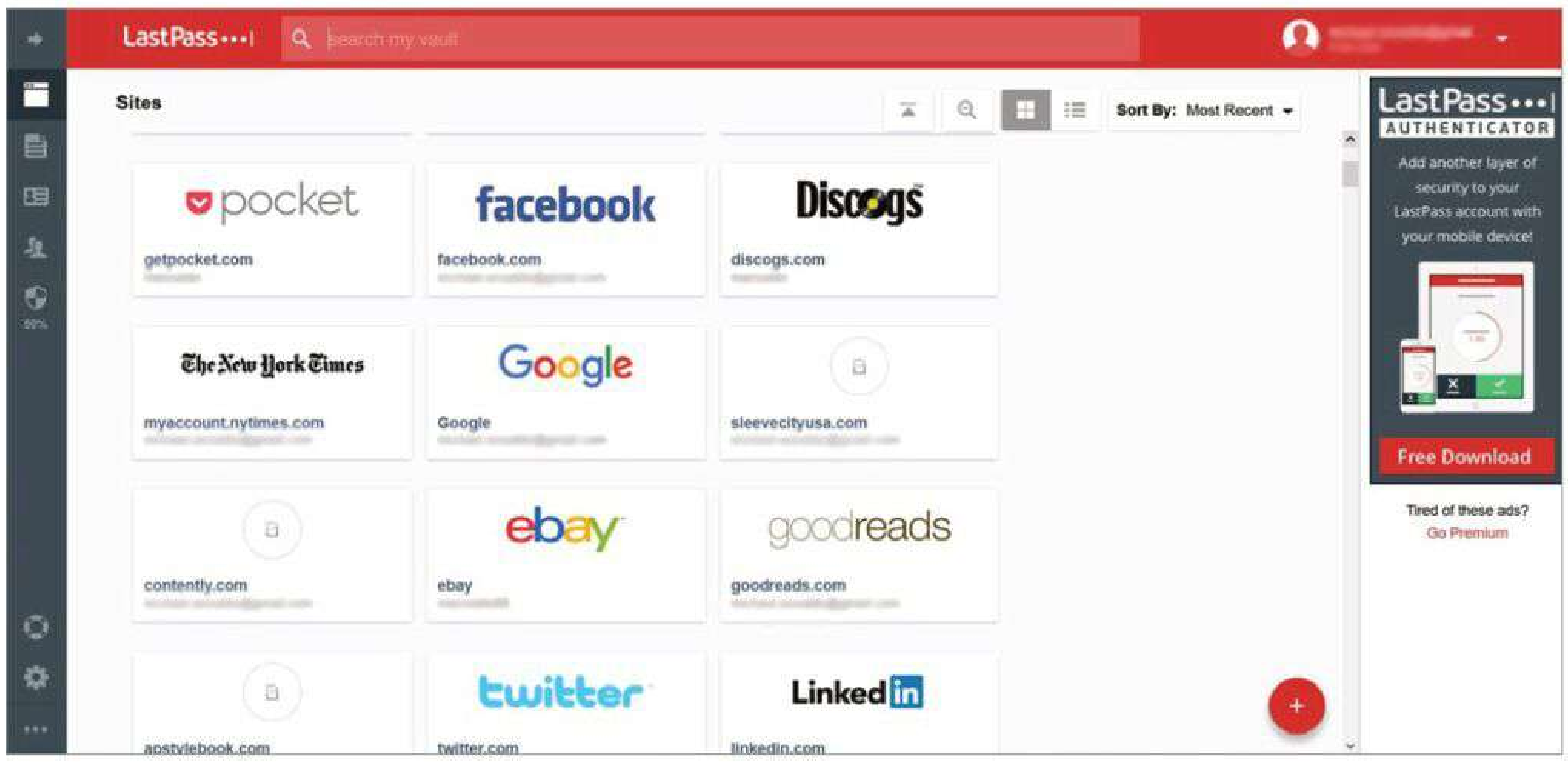
Thank you,

Microsoft has some examples of phishing attacks on its website.

Because open redirects can start with any primary domain and end with any destination, these phishing links can start with a legitimate site, and then go to a malicious page.

Adding further complexity to this scheme is the use of captchas to lend an air of authenticity. Users who believe they're on a genuine site will then enter login credentials in the belief they're accessing a notification, report, or even Zoom meeting, only to encounter a fake error page claiming a session time-out or incorrect password—prompting a second entry of login credentials. After the phishing attempt has successfully captured the user ID and password twice, users get redirected to another genuine website.

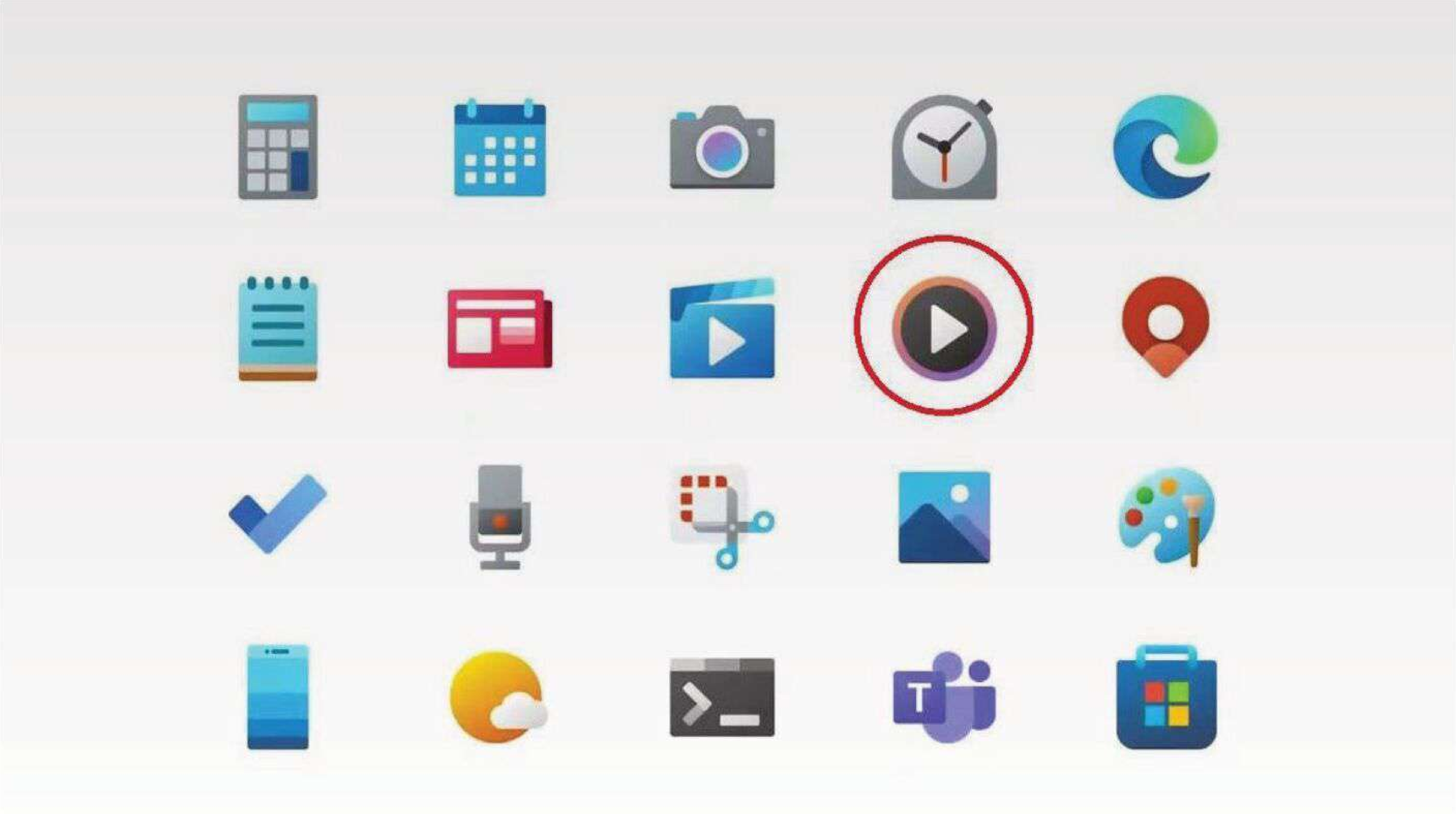
You can see specific examples of this attack and a sample list of malicious destination URLs in Microsoft's blog post, but you don't need to dig that deep in order to protect yourself. Instead, start using a password manager (go.pcworld.com/pmng). It won't automatically supply your login credentials on a spoofed site. You can also look over the whole URL when you land on a website, but it's not nearly as foolproof a method as a password manager. ⏻


LastPass
Search my vault
Sites
Sort By: Most Recent
pocket
getpocket.com
facebook
facebook.com
Discogs
discogs.com
The New York Times
myaccount.nytimes.com
Google
Google
sleevecityusa.com
contently.com
ebay
ebay
goodreads
goodreads.com
apstylebook.com
twitter
twitter.com
LinkedIn
linkedin.com
LastPass AUTHENTICATOR
Add another layer of security to your LastPass account with your mobile device!
Free Download
Tired of these ads?
Go Premium

LastPass is our favorite password manager.

These core apps look very different in Windows 11

Most of the Windows apps are simply being updated to look like Windows 11. But some are receiving new features, too. **BY MARK HACHMAN**



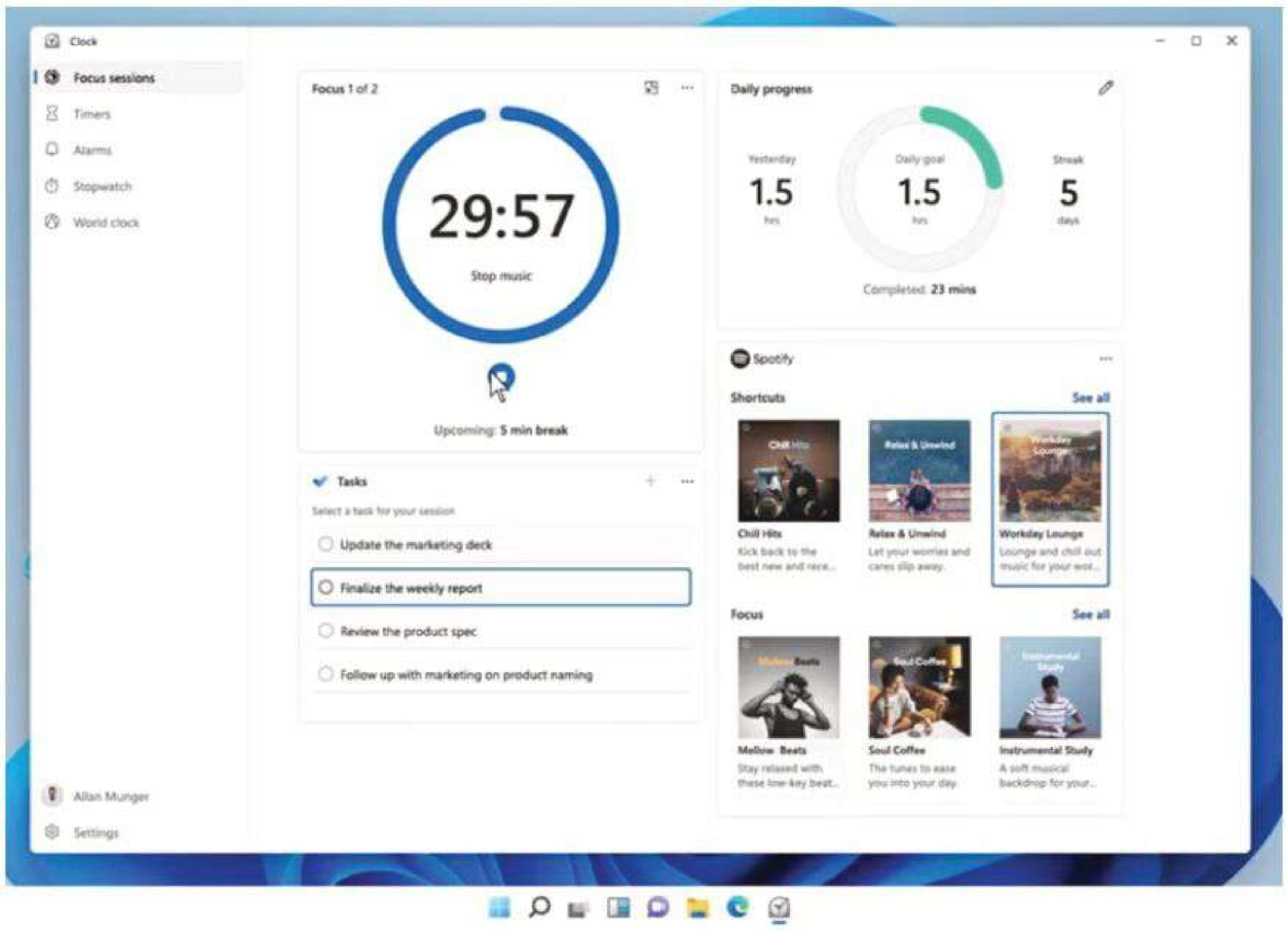
Windows 11 won't just change the Windows operating system—it will change the way some Windows apps look and feel, too. Though Windows 11 will launch this fall, Microsoft has already been highlighting several Windows apps that it is updating for Windows 11.

So far, Microsoft has shown off several Windows apps that it's reworking, including what you might consider core Windows apps: Mail and Calendar, Paint, and even the lowly Clock app. Below, we'll show you what to expect of these new apps within Windows 11. (Keep in mind that Windows 11 is officially in beta [go.pcworld.com/bt11]. Things may change between now and the final release.)

1. CLOCK (FOCUS SESSIONS)

Perhaps the most unexpectedly interesting update to Windows 11's suite of Windows

IMAGE: MICROSOFT


Clock
Focus sessions
Timers
Alarms
Stopwatch
World clock
Allan Munger
Settings
Focus 1 of 2
29:57
Stop music
Upcoming: 5 min break
Tasks
Select a task for your session
Update the marketing deck
Finalize the weekly report
Review the product spec
Follow up with marketing on product naming
Daily progress
Yesterday
1.5
hrs
Daily goal
1.5
hrs
Streak
5
days
Completed: 23 mins
Spotify
Shortcuts
See all
Chill Hits
Kick back to the best new and rece...
Relax & Unwind
Let your worries and cares slip away.
Workday Lounge
Lounge and chill out music for your wor...
Focus
See all
Mellow Beats
Stay relaxed with these low-key beat...
Soul Coffee
The tunes to ease you into your day.
Instrumental Study
A soft musical backdrop for your...

Microsoft has dramatically revamped its Windows 11 Clock app, adding Focus Sessions with Spotify integration.

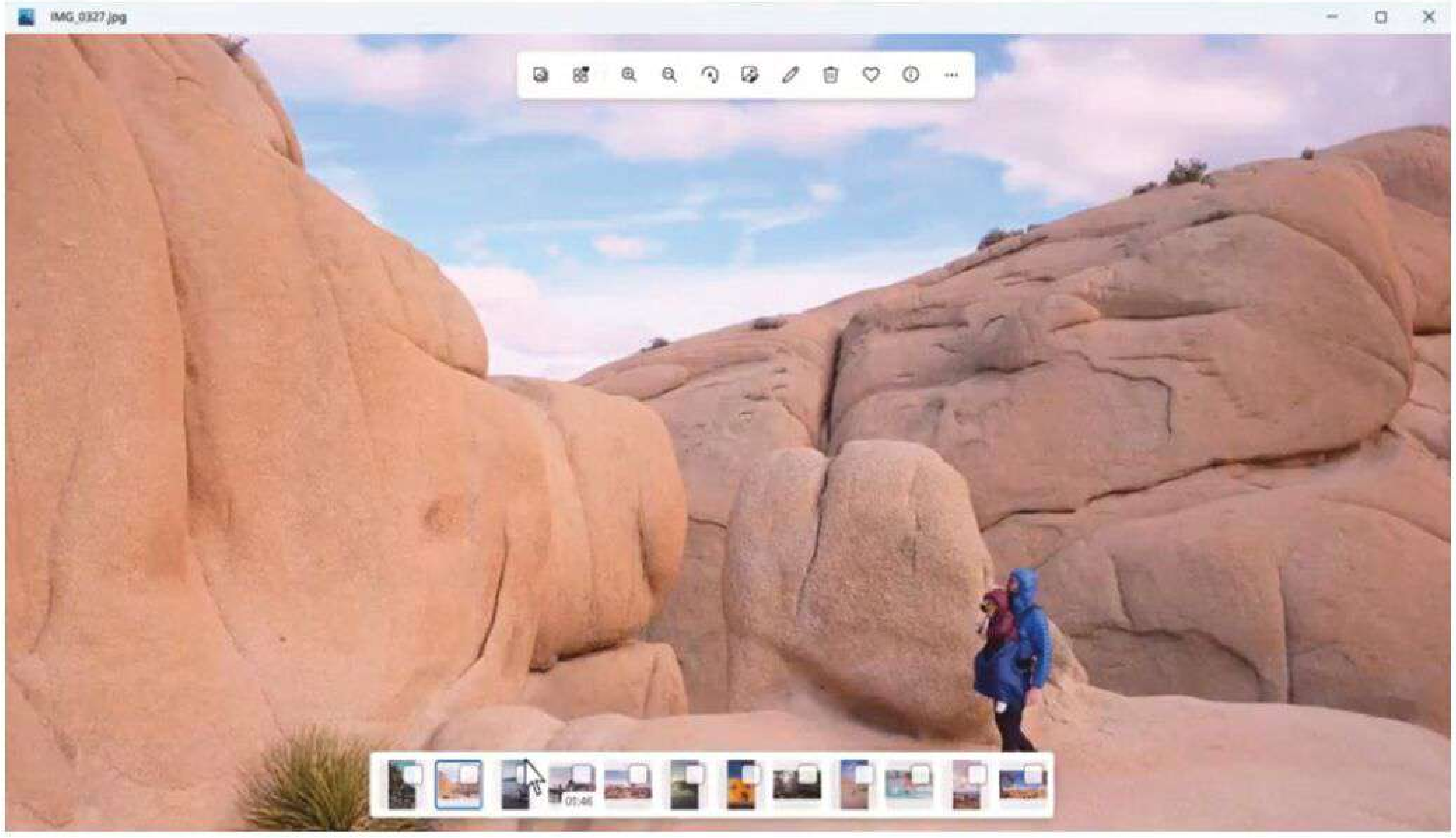
apps is the lowly Clock app. Now, in addition to the usual suite of Timers, Alarms, a Stopwatch, and a World Clock, Microsoft has added Focus Sessions and Microsoft To-Do.

Microsoft describes Focus Sessions as a major new feature, and it's easy to see why. If you're the type of person who concentrates best when music plays, you'll love Focus Sessions and its integration with Spotify. Focus Sessions allows you to block out a period of time, with a literal stopwatch counting it down. During the Focus Session, you can connect your account to Spotify and ask it to play classical music, electronic, trance—whatever keeps you in the zone. (There's a mute button, too, in case you receive a call.)

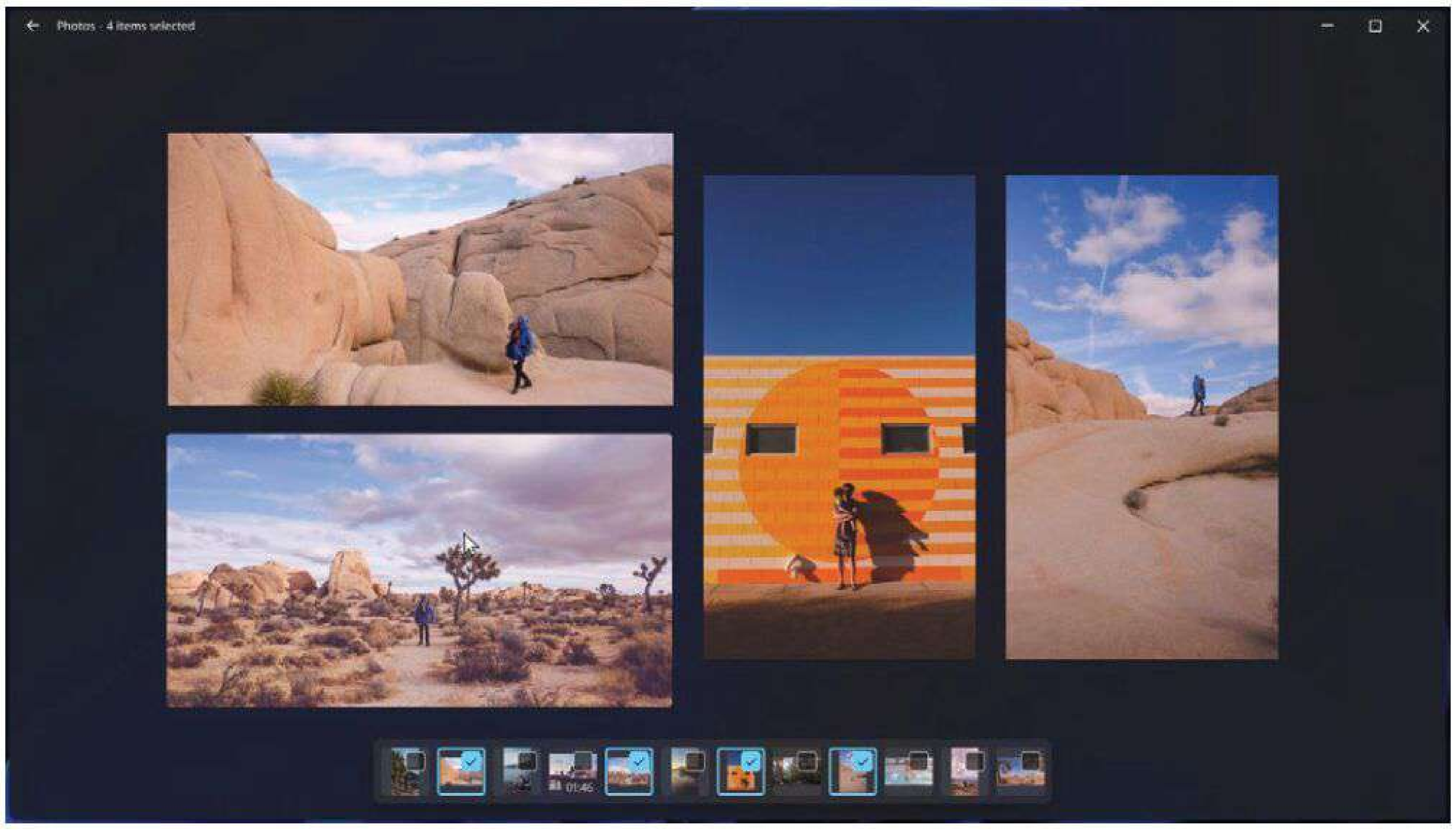
The Clock app also includes integration with To-Do, so you can accomplish tasks and check them off. Finally, you'll even be able to configure "streaks"—a habit-building feature that's part of Microsoft Rewards—to set a daily goal and then accomplish it, day after day.

2. PHOTOS

Microsoft doesn't appear to be doing too much to the Photos app within Windows 11, though we can see at least one new element to the user interface—a row of thumbnail images


IMG_0327.jpg

Microsoft is redesigning the Photos app within Windows 11.


Photos - 4 items selected

Windows 11 Photos will also allow you to compare photographs.

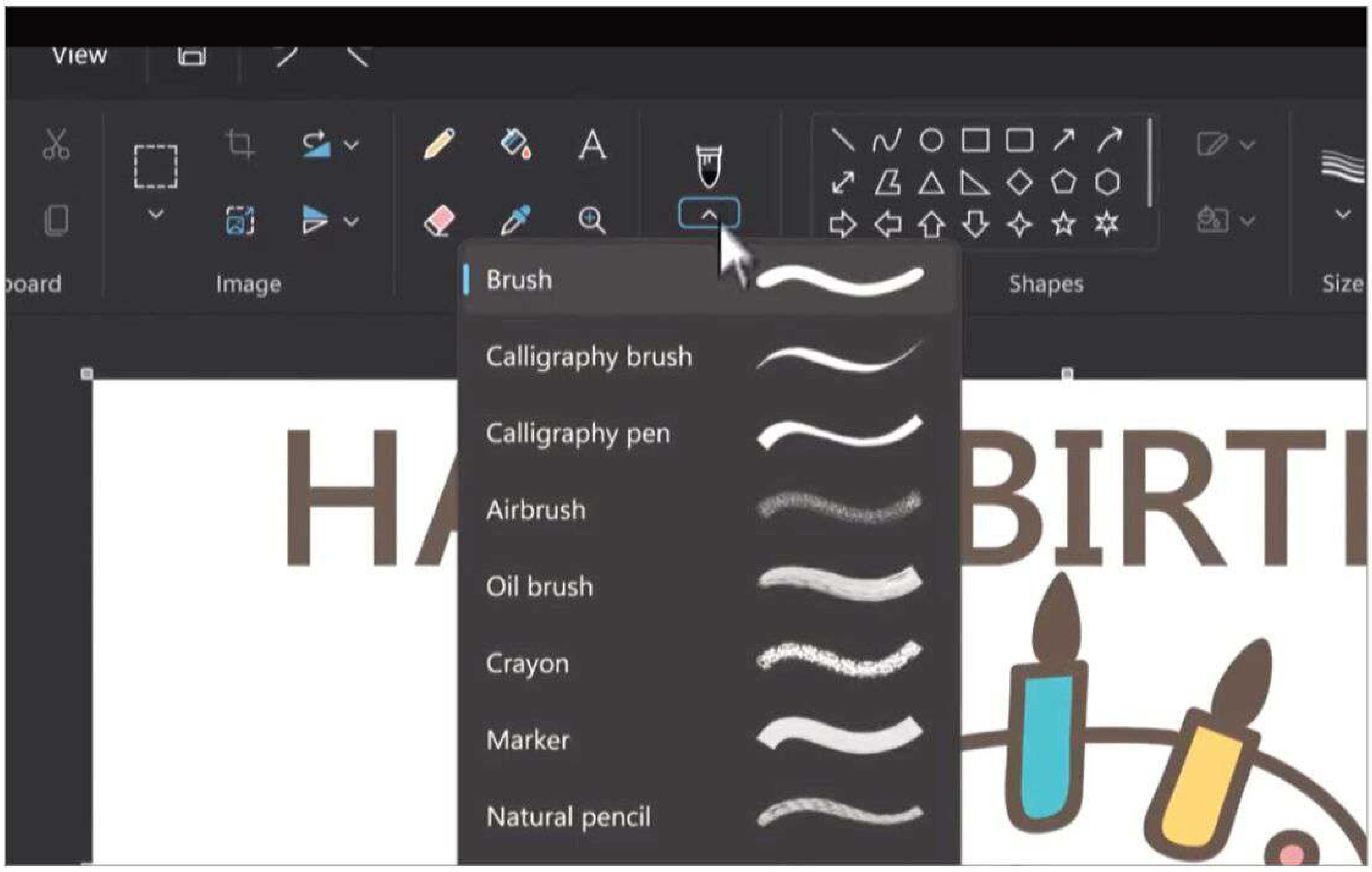
at the bottom of the screen. This image comes from a teaser that Microsoft chief product officer Panos Panay posted to Twitter.

Otherwise, Photos has added the familiar rounded corners and other visual elements of Windows 11.

3. PAINT

Microsoft Paint has rolled successful saves against death many times over, surviving decisions to deprecate the beloved utility in 2017 (go.pcworld.com/blut) as well as relegate it to a downloadable app (go.pcworld.com/dnap). In 2019, Microsoft said Paint would remain a part of Windows 10 for now (go.pcworld.com/remn).

The decision by Microsoft chief product officer Panos Panay to show off a new look for Paint in Windows 11 affirms that Paint has survived yet again. In a video, Panay revealed what looks more like a user-interface update than any major change in functionality (go.pcworld.com/vdeo). (One omission is the reference to Paint3D that currently exists with Windows 10's Paint.) Still, updating the


View
oard
Image
Shapes
Size
Brush
Calligraphy brush
Calligraphy pen
Airbrush
Oil brush
Crayon
Marker
Natural pencil
HA
BIRT

The updated Windows 11 Paint app has a more intuitive interface.

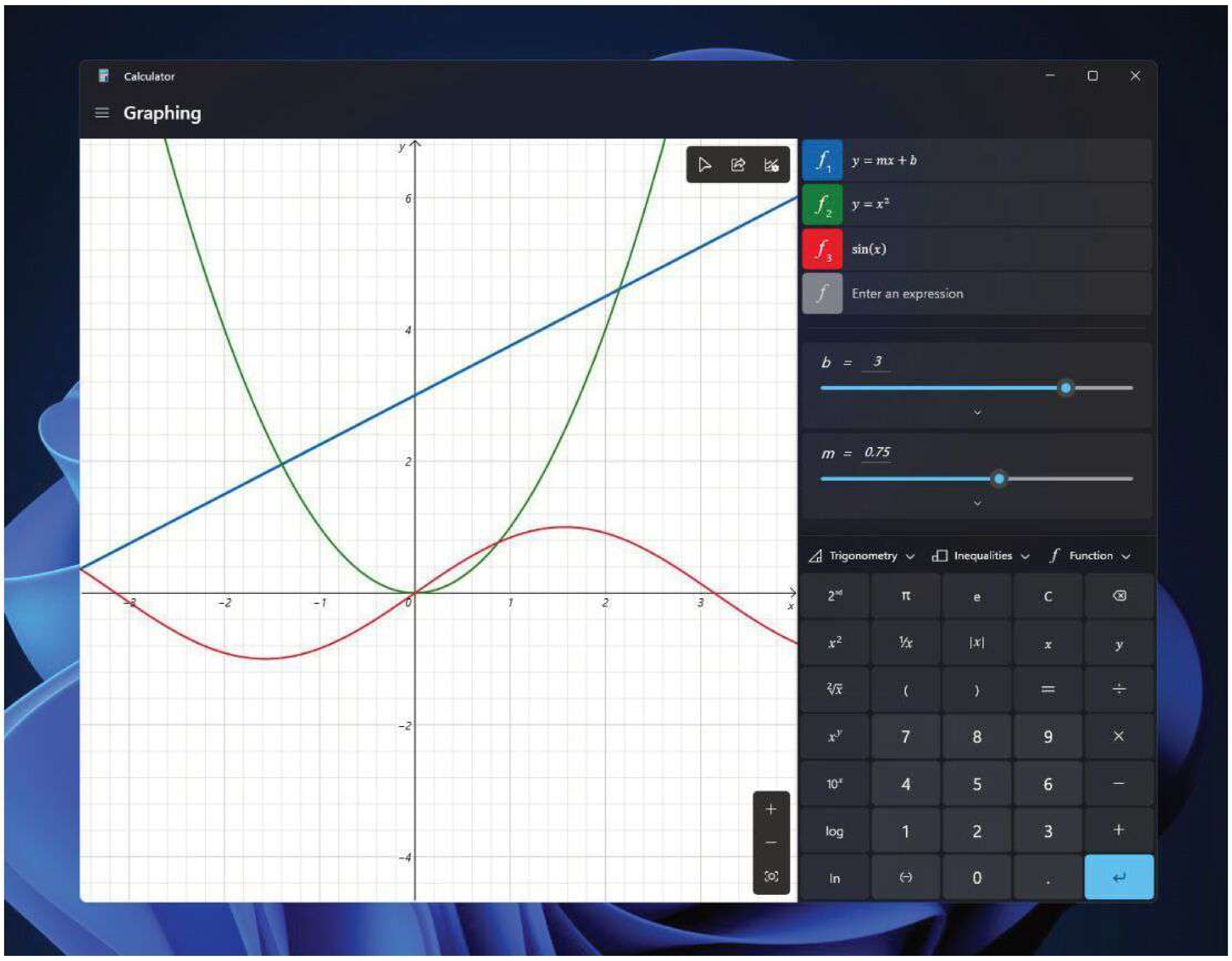
iconography as well as the drop-down functionality is a welcome step, and simply putting in the work shows that Microsoft remains committed to Paint as a whole.

4. CALCULATOR

Calculator is a surprisingly powerful tool hidden within Windows 10, though most people probably use it merely for numerical calculations. Inside it is a graphing calculator (remember to expand the app's window to use all of its functionality!), the ability to convert measurements and currencies, a scientific and programmer calculator, and more. None of that functionality appears to be changing for Windows 11, but the app will include a new theme setting. It's also been rewritten in C#, which Microsoft did as a way to allow the public to contribute to the app on GitHub, code in new features, and update the app more frequently over time.

5. SNIPPING TOOL

Anyone who captures screenshots regularly should know that Microsoft has not one but two tools for doing so: the legacy Snipping Tool, and the newer Snip & Sketch. For years, Microsoft has posted a notice in the former app that it would be replaced by Snip & Sketch…but now that doesn't appear to be the case.



$y = mx + b$

$y = x^2$

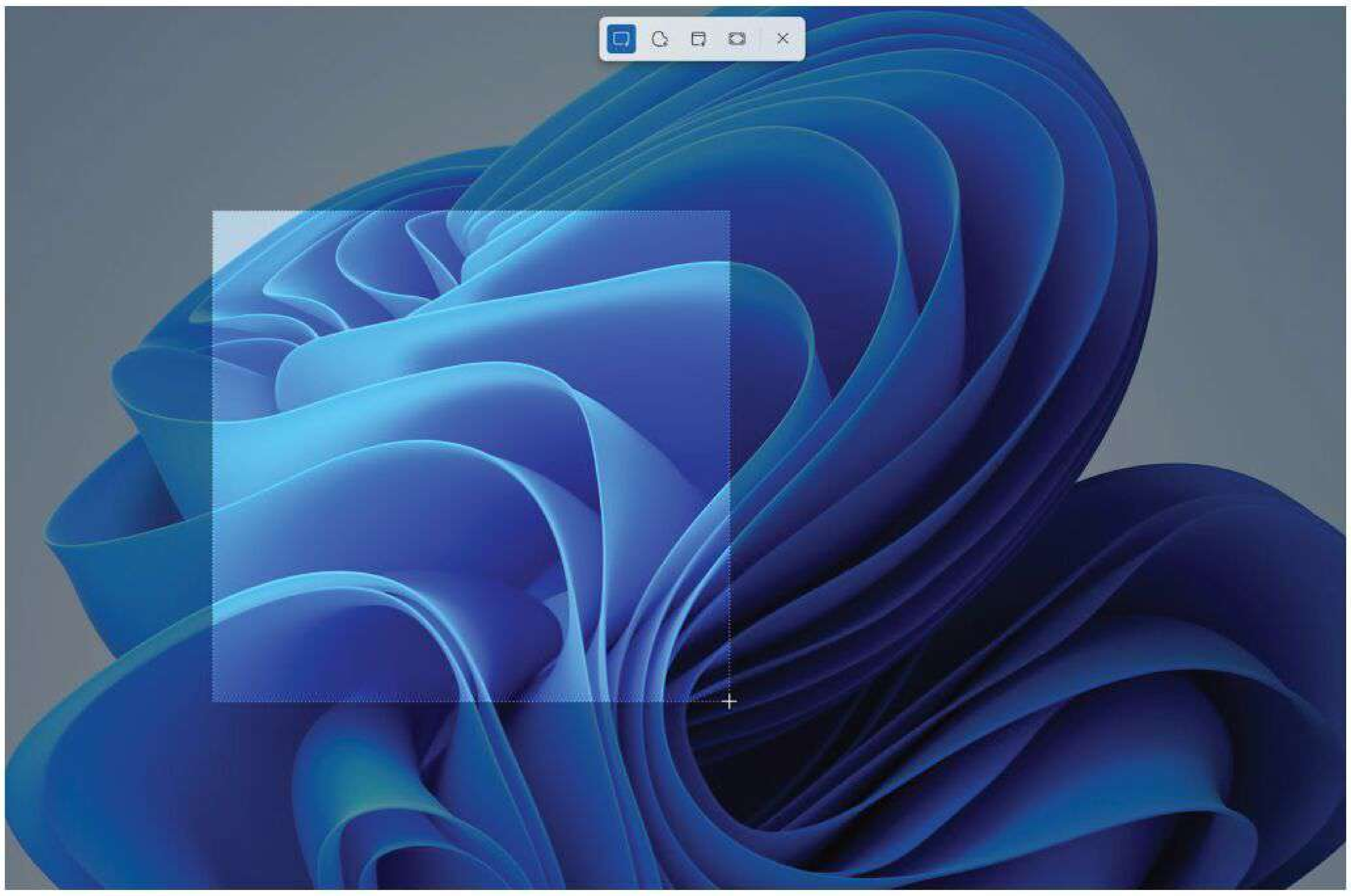
$\sin(x)$

$b = 3$

$m = 0.75$

The Windows Calculator app (shown here within Windows 11) hides some powerful features like this graphing calculator.

"Both the classic Snipping Tool and Snip & Sketch apps have been replaced by a new Snipping Tool app that represents the best experiences of both apps in the next evolution of screen capture for Windows," Microsoft's Dave Grochocki wrote in a blog post (go.pcworld.com/dvgr).

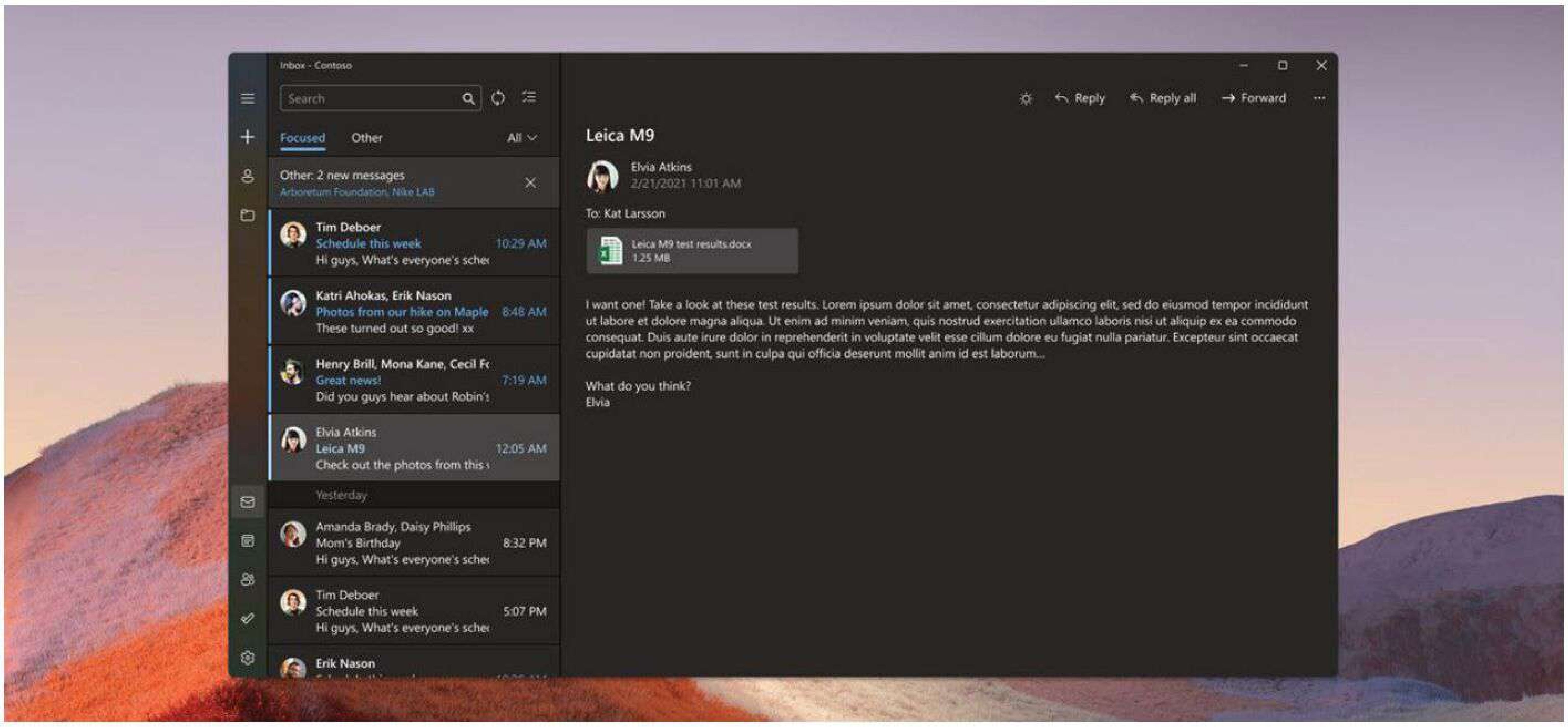


Microsoft has revamped the Snipping Tool.

Panay showed off a revamped Snipping Tool that uses the Snip & Sketch shortcut (Win + Shift + S) but leaves the other snipping options unchanged. Aesthetically, the app now has the rounded corners and other visual cues of Windows 11—even dark mode. There will be some additional editing tools for annotations and improved cropping functionality as well.

6. MAIL AND CALENDAR

Last but not least are Windows 11's own Mail and Calendar apps, which eliminate a lot of the visual clutter within Outlook and provide a simplified, streamlined experience. Microsoft doesn't seem to be planning to change anything here, simply giving the user interface the familiar rounded corners of Windows 11.



Other: 2 new messages
Arboretum Foundation, Nike LAB

Tim Deboer
Schedule this week 10:29 AM
Hi guys, What's everyone's sche

Katri Ahokas, Erik Nason
Photos from our hike on Maple 8:48 AM
These turned out so good! xx

Henry Brill, Mona Kane, Cecil F
Great news! 7:19 AM
Did you guys hear about Robin'

Elvia Atkins
Leica M9 12:05 AM
Check out the photos from this

Amanda Brady, Daisy Phillips
Mom's Birthday 8:32 PM
Hi guys, What's everyone's sche

Tim Deboer
Schedule this week 5:07 PM
Hi guys, What's everyone's sche

Erik Nason

Leica M9

Elvia Atkins
2/21/2021 11:01 AM

To: Kat Larsson

Leica M9 test results.docx
1.25 MB

I want one! Take a look at these test results. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum...

What do you think?
Elvia

For now, Microsoft isn't doing much with Mail and Calendar except for updating the user interface.

ad COUNCIL
American Lung Association
My kid would never vape.

More than 5 million American kids vape.

Which means, they're being set up for a lifetime of addiction.

Good students. Athletes.

Kids who'd never smoke regular cigarettes.

All types of kids.

Maybe even yours.

Talk to your kid about vaping. Start by getting the facts at

TalkAboutVaping.org

GET YOUR HEAD OUT OF THE CLOUD

Dell XPS 17: The ultimate content creation laptop

With a giant screen and thin profile, the Dell XPS 17 is perfectly built for content creators on the go. **BY GORDON MAH UNG**

PCWorld EDITORS' CHOICE

Warning: Dell's XPS 17 9710 is no gaming laptop (go.pcworld.com/nogl). If you just wrinkled your nose up in disapproval, that's fine—from Dell's point of view, anyway. That's because the XPS 17 9710 is seemingly designed to appeal to content creators, not those focused only on gaming.

You might have difficulty wrapping your head around the concept since gaming laptops with a higher-resolution screen typically pass as content creation laptops. We admit we thought that too, but over time, we've come to finally understand what Dell is doing here—very successfully too. Adobe users in particular will love this notebook.

IMAGE: DELL

SPECS

The left side of the XPS 17 9710 features two Thunderbolt 4 ports and a wedge-style lock port.

CPU: Intel 8-core 11th gen Core i7-11800H.

GPU: Nvidia GeForce RTX 3060 Laptop at 70 watts TGP.

RAM: 32GB DDR4/3200 in dual-channel mode.

Storage: 1TB Samsung P9A1 PCIe Gen 4 SSD (up to 2 M.2 drives).

Battery: 97 watt-hour.

Network: WiFi 6 and Bluetooth 5.1.

Panel: 17-inch touch screen with 10-bit color depth and 3840x2400 resolution.

Webcam and biometrics: 720p IR camera with Windows Hello support and fingerprint reader.

Weight and size: The laptop is 14.74x9.76x0.77 and 5.4 pounds with touch screen (4.9 pounds without) and 1 pound for 130-watt power brick.

Ports: We'll let the pictures do the talking but there are four Thunderbolt 4 ports, a UHS-III SD Card reader, and a combo analog audio jack and wedge lock port, which you can see below.

The right side of the XPS 17 9710 features two more Thunderbolt 4 ports, a UHS-III SD Card reader and an analog headphone jack. SD Card readers can vary in speed (go.pcworld.com/vary), but the XPS 17's is top notch. We saw read and write performance near the maximum speed of our UHS-II card.

There's no USB-A port, but Dell does at least include a USB-A and full-size HDMI dongle. While we understand why PC makers are giving USB-A the boot—although we still don't agree with it—we think it's an oversight

Two more Thunderbolt 4 ports, a UHS-III SD Card reader, and headphone jack are on the right side of the XPS 17.

of Dell not to include a gigabit ethernet adapter too. Content creation people love high-speed LAN transfers, Dell.

Content creators will love the star of the show, though. While the 11th-gen Intel CPU and Nvidia GeForce RTX 3060 GPU are indeed attention getters, the real feature that sets the Dell XPS 17 9710 apart is its giant 17-inch screen.

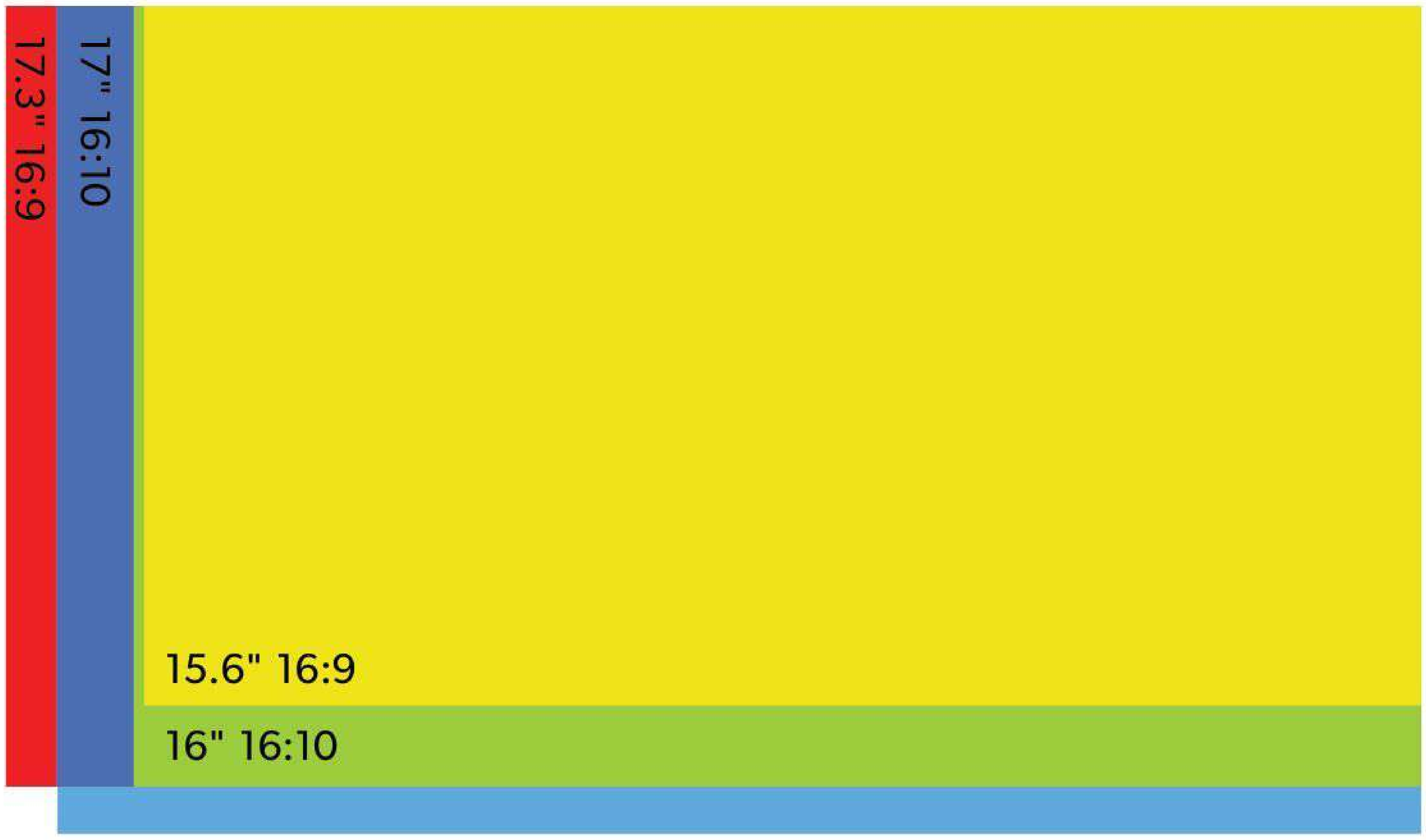
SCREEN SIZE

Don't let that number fool you. You may be thinking it's "only" a 17-inch screen going up against laptops with 17.3-inch panels, but the 16:10 aspect ratio of the XPS 17 matters. Yes, we know, 17.3 is more than 17—but if you actually measure the vertical and horizontal height of the 17-inch 16:10 panel on the XPS 17, it's actually slightly larger than 17.3-inch panels in terms of viewable area.

The other natural competitors to the XPS 17 are recent crops of 16-inch notebooks using 16:10 aspect ratio screens as well. But while a 16-inch screen sounds pretty close to a 17-inch screen, in actual real estate the Dell XPS 17's display is almost 13 percent bigger than a comparable 16-inch screen, such as the ones in the MSI Creator Z16 (go.pcworld.com/cz16) or Asus ROG Zephyrus M16 (go.pcworld.com/zm16).

To give you an idea of how much larger, we physically measured the XPS 17's panel to compare it to the physical dimensions of other popular screen dimensions.

What's impressive about the XPS 17 9710 is that while it offers a screen slightly larger than that of a 17.3-inch 16:9 laptop, its footprint is only an inch wider than that of most thin-profile 15.6 gaming laptops. That's 26 percent more viewable screen space in a laptop just an inch wider. So yes, if you want as much panel packed into the tiniest possible laptop, the XPS 17 is your answer.



Ratioed: Although 17.3 is a larger number than 17, the XPS 17's 16:10 panel (blue) actually offers slightly more viewable area than the 17.3-inch screen (red).

The XPS 17 features a giant track pad and a fair (but not our favorite) keyboard.

KEYBOARD, TRACKPAD, AND AUDIO

Keyboards and trackpads matter. The keyboard on the XPS 17 isn't our favorite—it's a tad bouncy and a little stiff—but it's fine. The trackpad is ginormous, but palm rejection seems to work well enough and we didn't experience any cursor jumps even while intentionally mashing our palms on the trackpad.

The keyboard doesn't feature a 10-key setup, which some people will complain about, but that keeps it centered—a good thing that also allows more space for top-firing speakers. While most thin gaming laptops tend to have pretty poor audio, the XPS 17 gets loud and offers a decent midrange and bass. In fact, you can feel the laptop vibrating when you crank up the sound. Some might say that's too loud, but we'd take it over some gaming laptops that are tuned by an angry librarian.

PERFORMANCE

Performance is part of what matters in a sleek performance laptop like this, so let's kick things off with a look at the XPS 17 in Cinebench R15, an older version of Maxon's 3D-rendering benchmark. Cinebench loves more CPU cores and threads, and we see Intel's 11th-gen Core i7-11800H offers outstanding performance compared to a stack of older CPUs.

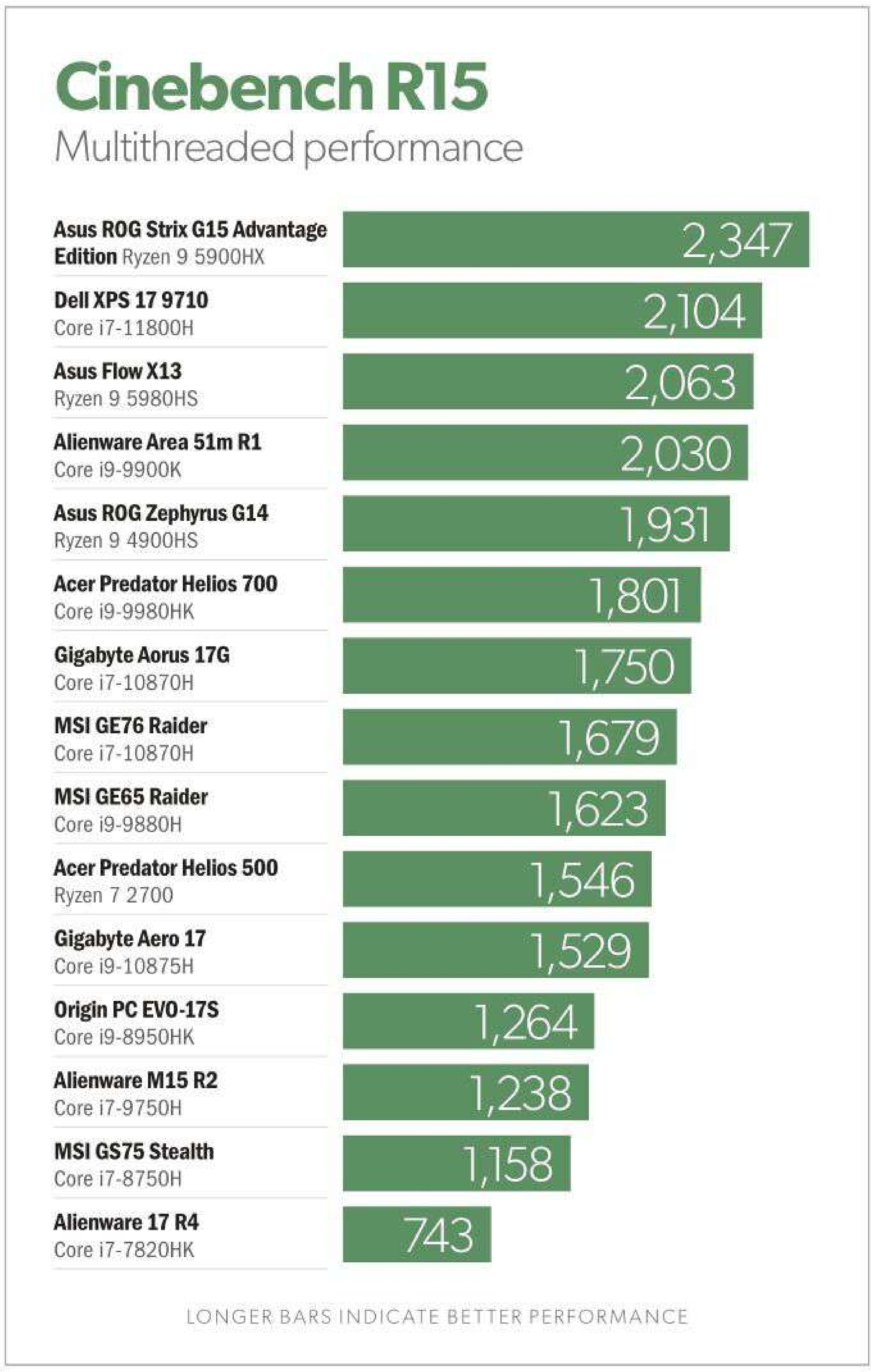
It's even slightly faster than the desktop Core i9-9900K CPU in the original Alienware

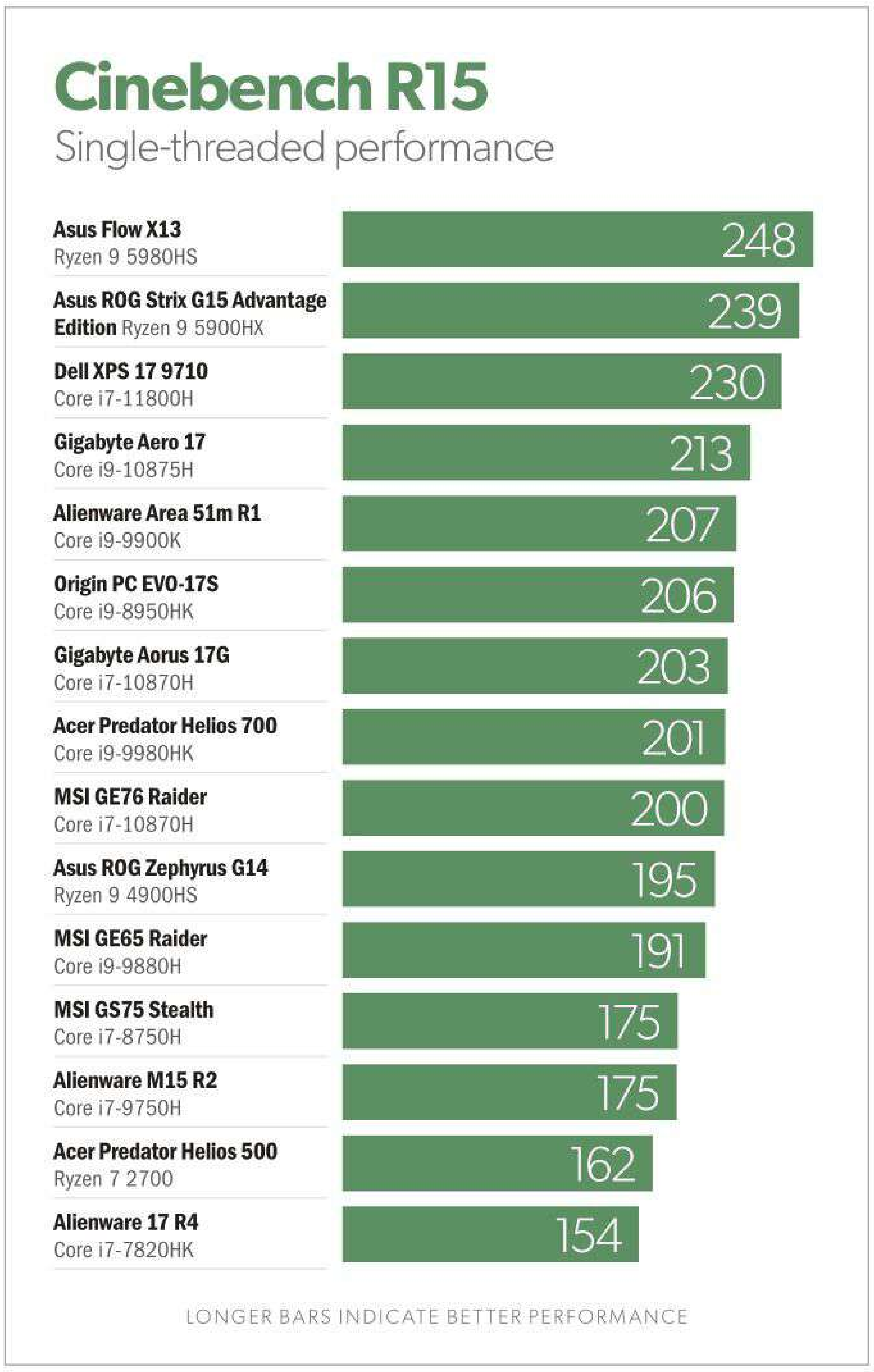
Area 51m R1 (go.pcworld.com/a51r), a gaming notebook that was far thicker and heavier in your bag.

For people who actually use applications that take advantage all of those CPU cores, that's good stuff, but the vast majority of applications commonly used by consumers today are often very lightly threaded. We also run Cinebench R15 using a single thread. You can see that the 11th-gen Core i7 in the XPS 17 does fairly well, but it's still outperformed by the pair of Ryzen 9 CPUs. Both of those laptops are thicker, however (and rely on Ryzen 9 instead of Ryzen 7 chips).

Cinebench R15 uses older technology under the hood, so to give you an idea of how the XPS 17 handles in a newer rendering engine, we ran Cinebench R20. First up is the multithreaded performance, which puts the Core i7 in the XPS 17 9710 on pretty good ground. It's not much slower than an 11th-gen Core i9 in a similarly sized laptop.

In Cinebench R20's single-threaded benchmark, the XPS 17's Core i7 falls basically dead even with two Ryzen 9 laptops. The

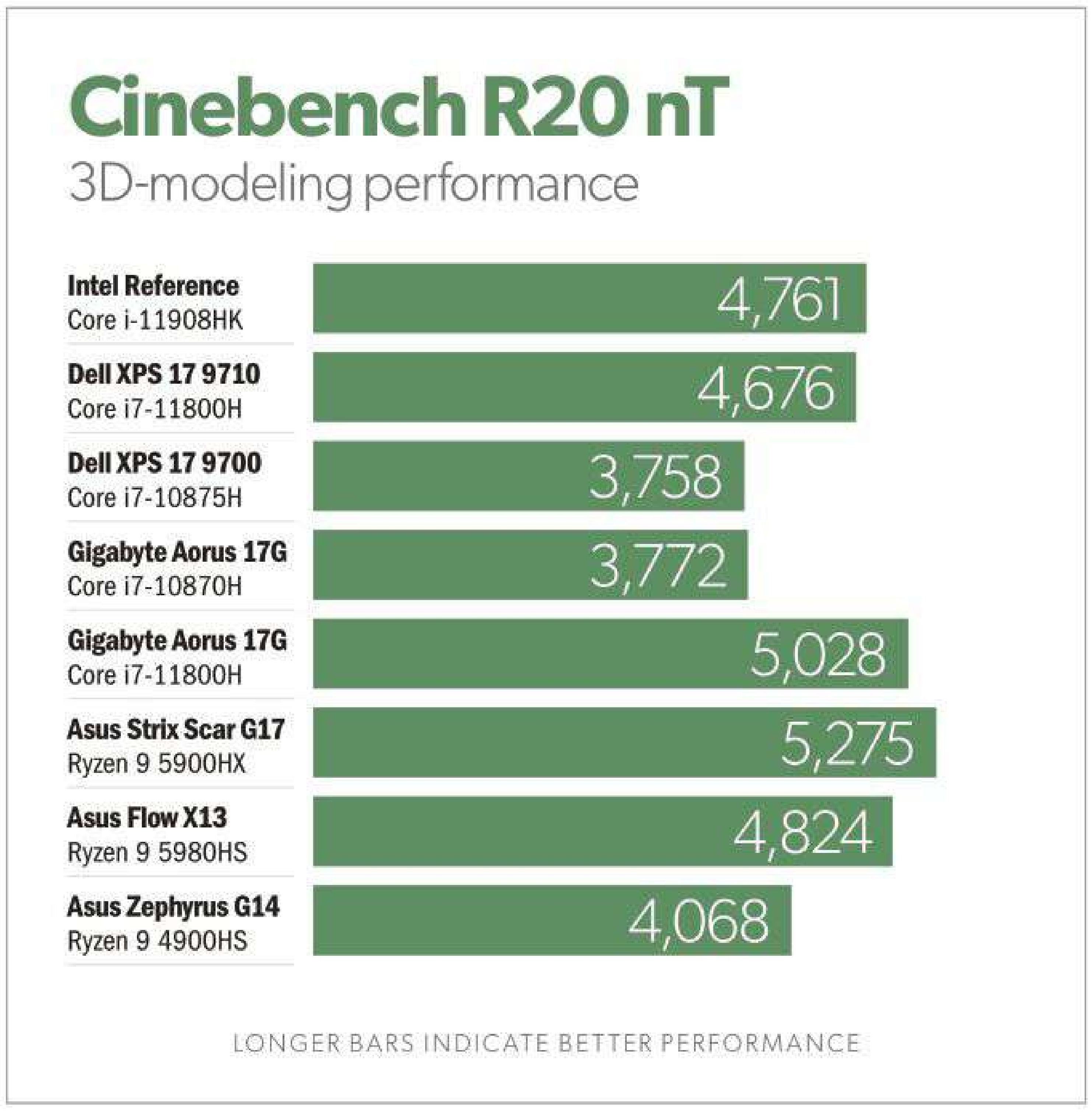




main takeaway is that 11th-gen Intel laptops—as well as Ryzen 5000 laptops—offer hefty improvements over 10th-gen Intel laptops.

We don’t normally run artificial intelligence–based benchmarks for laptops, but in the interest of seeing where the XPS 17 9710 falls, we ran Nero’s free Score benchmark. It’s a slightly older version but it measures DL Boost performance—which improves image processing using AI—as applied to image tagging. No surprise here: The 11th-gen Intel laptops with DL Boost support crush older 10th-gen laptops as well as those using AMD’s Ryzen 5000 chips. How much this matters really depends on Intel’s ability to convince more app developers to support DL Boost, but from what we’ve seen, it’s promising.

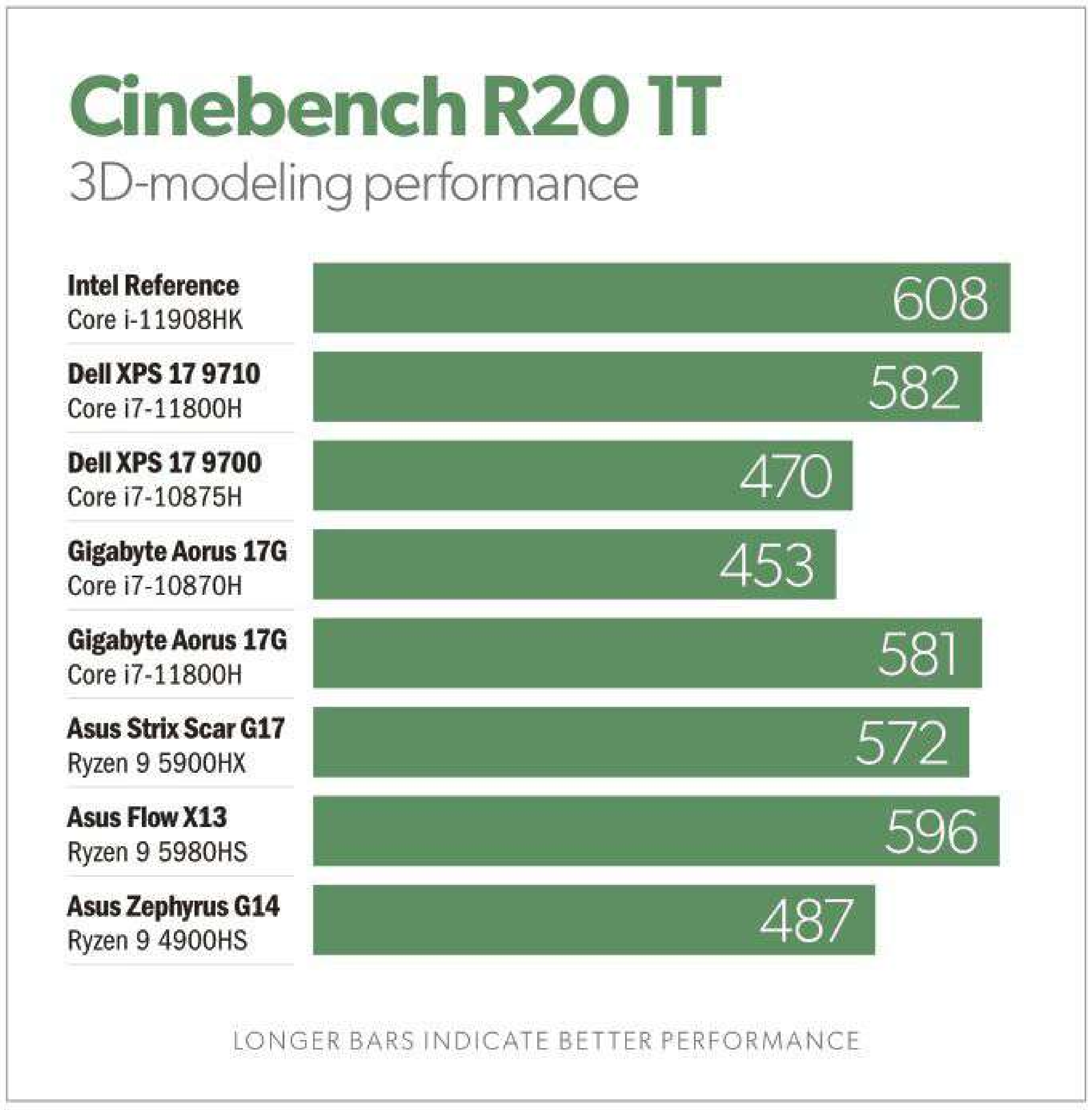
Our next result uses Handbrake to transcode a 30GB file using the Android Tablet preset. We like this test as it takes 20 minutes and longer for most laptops to complete. Since it leverages all available CPU cores, laptops with better cooling (or cooler-running CPUs) typically win. The thin XPS 17 falls around the middle of the pack



Cinebench R20 nT

3D-modeling performance

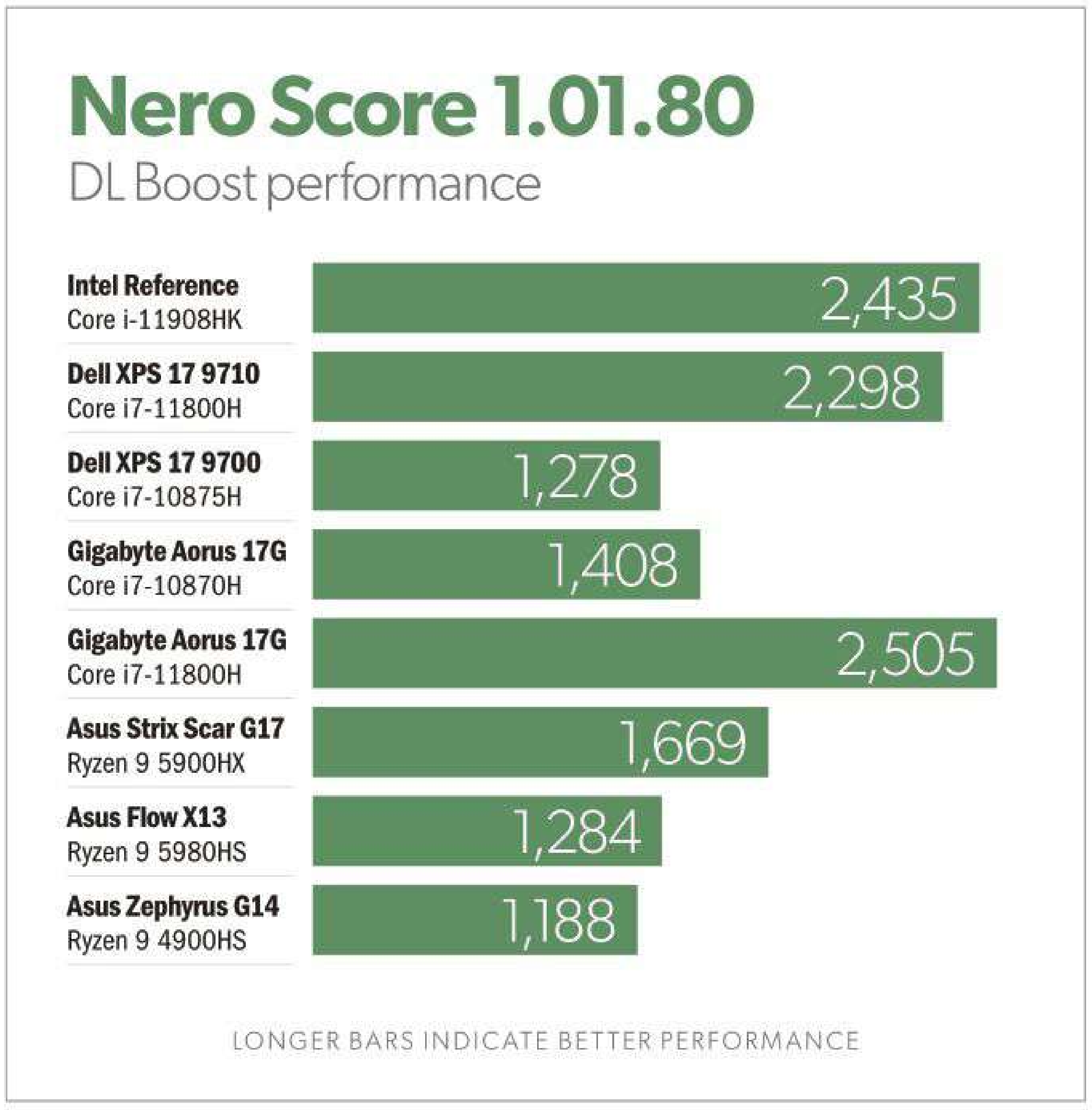
LONGER BARS INDICATE BETTER PERFORMANCE



Cinebench R20 1T

3D-modeling performance

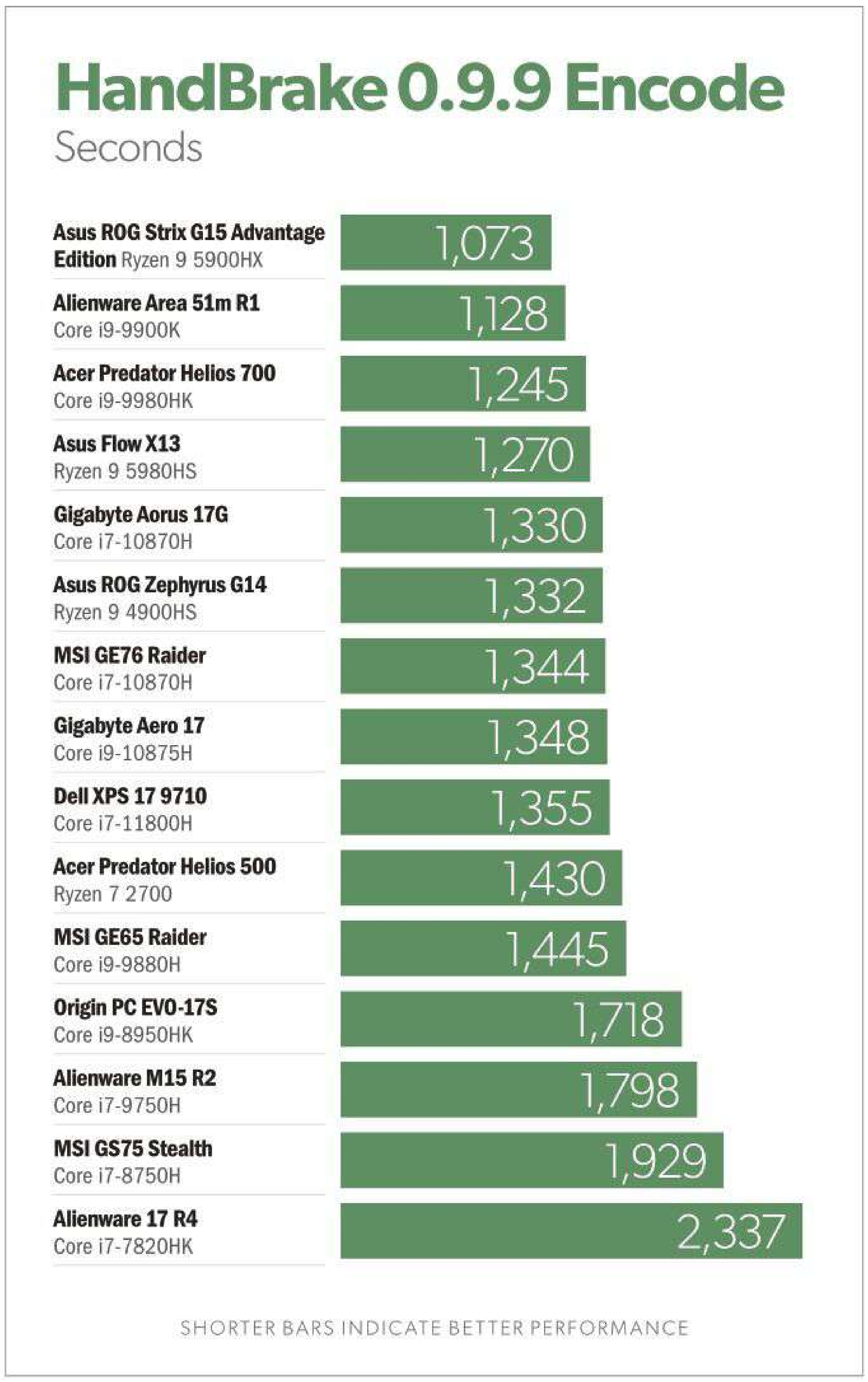
LONGER BARS INDICATE BETTER PERFORMANCE

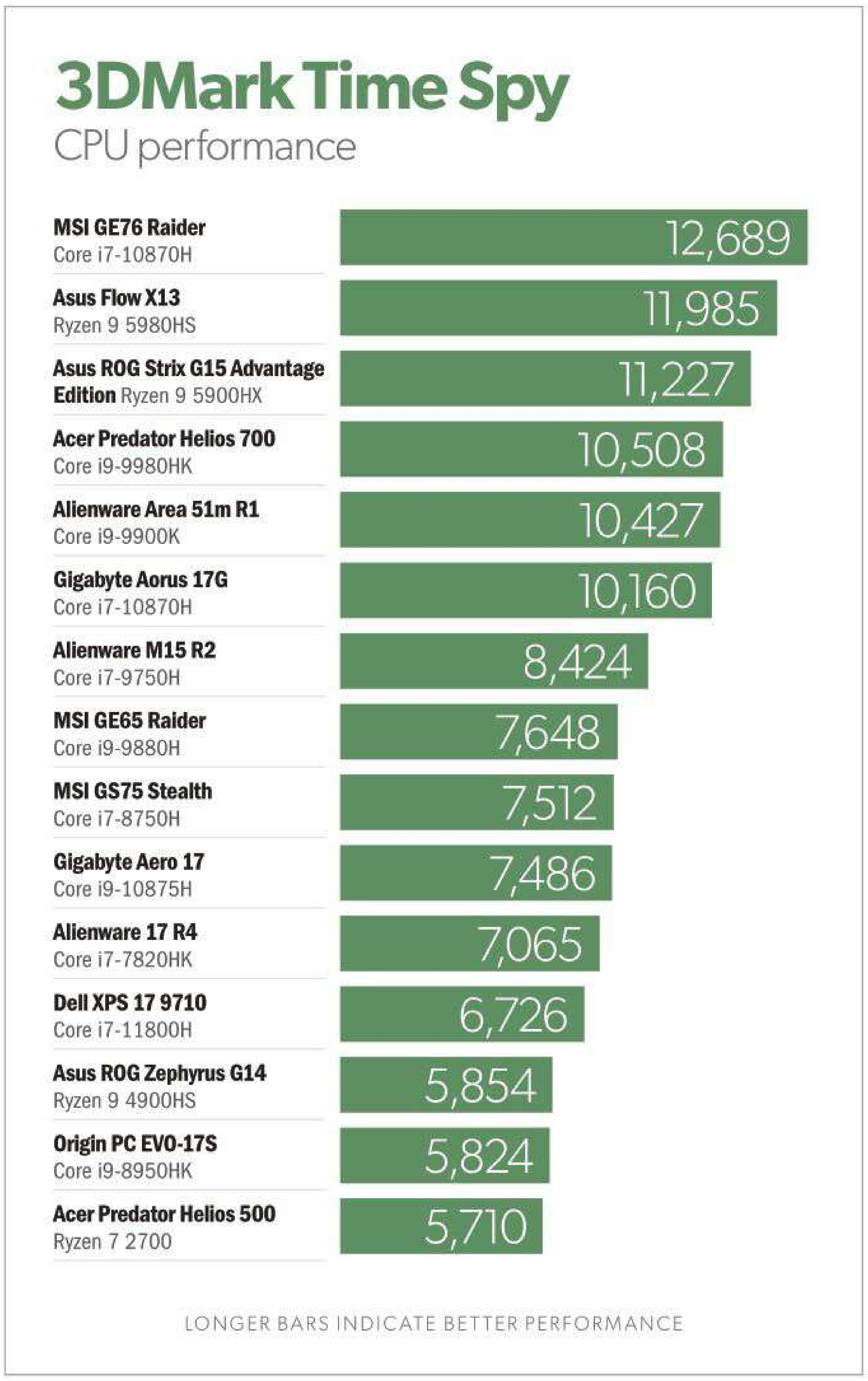


Nero Score 1.01.80

DL Boost performance

LONGER BARS INDICATE BETTER PERFORMANCE





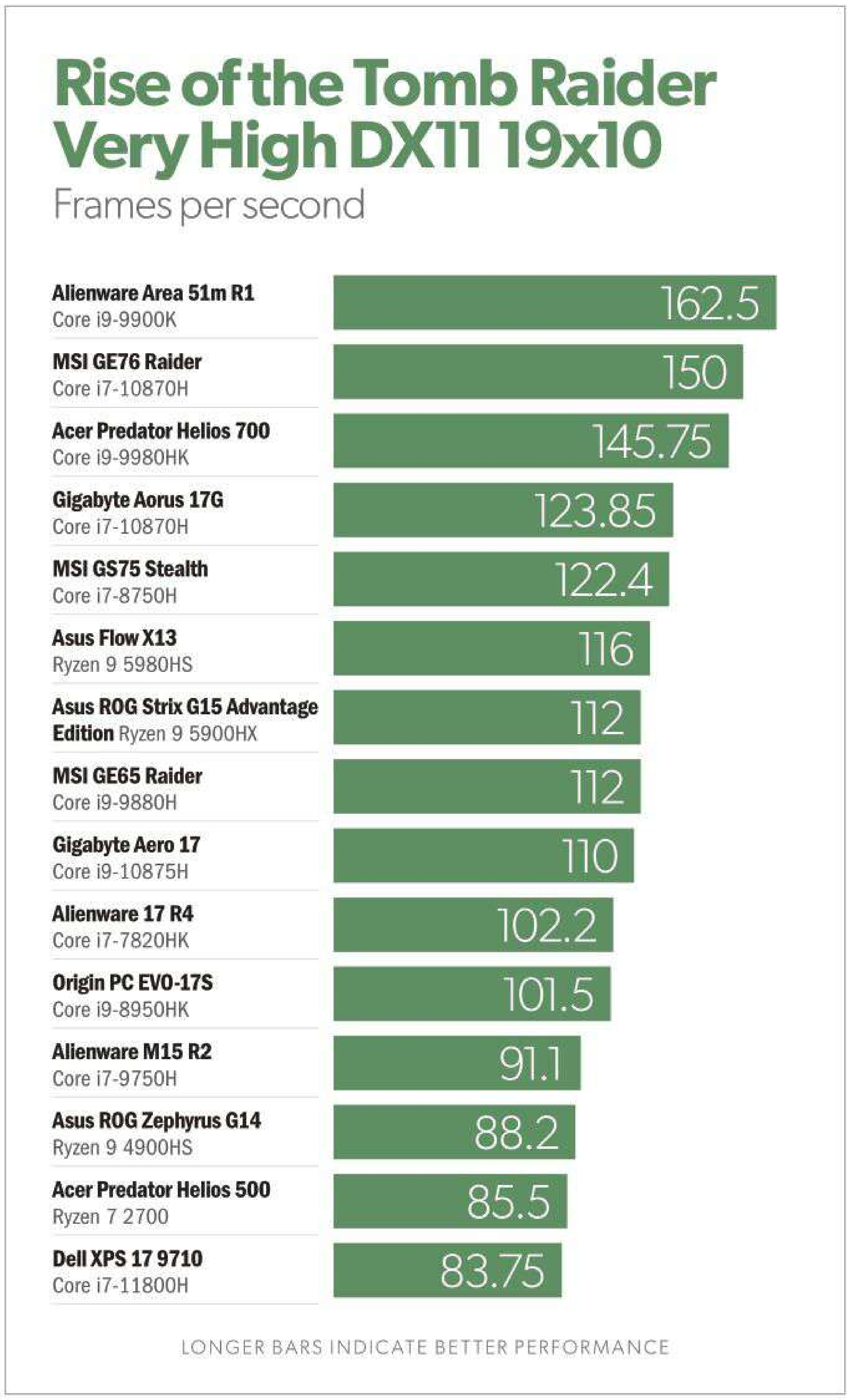
but most of the laptops above it are essentially tied with its performance, and several are much thicker and larger. Overall, Dell's notebook isn't quite as fast as the gaming laptops at the top, but it's really very competitive.

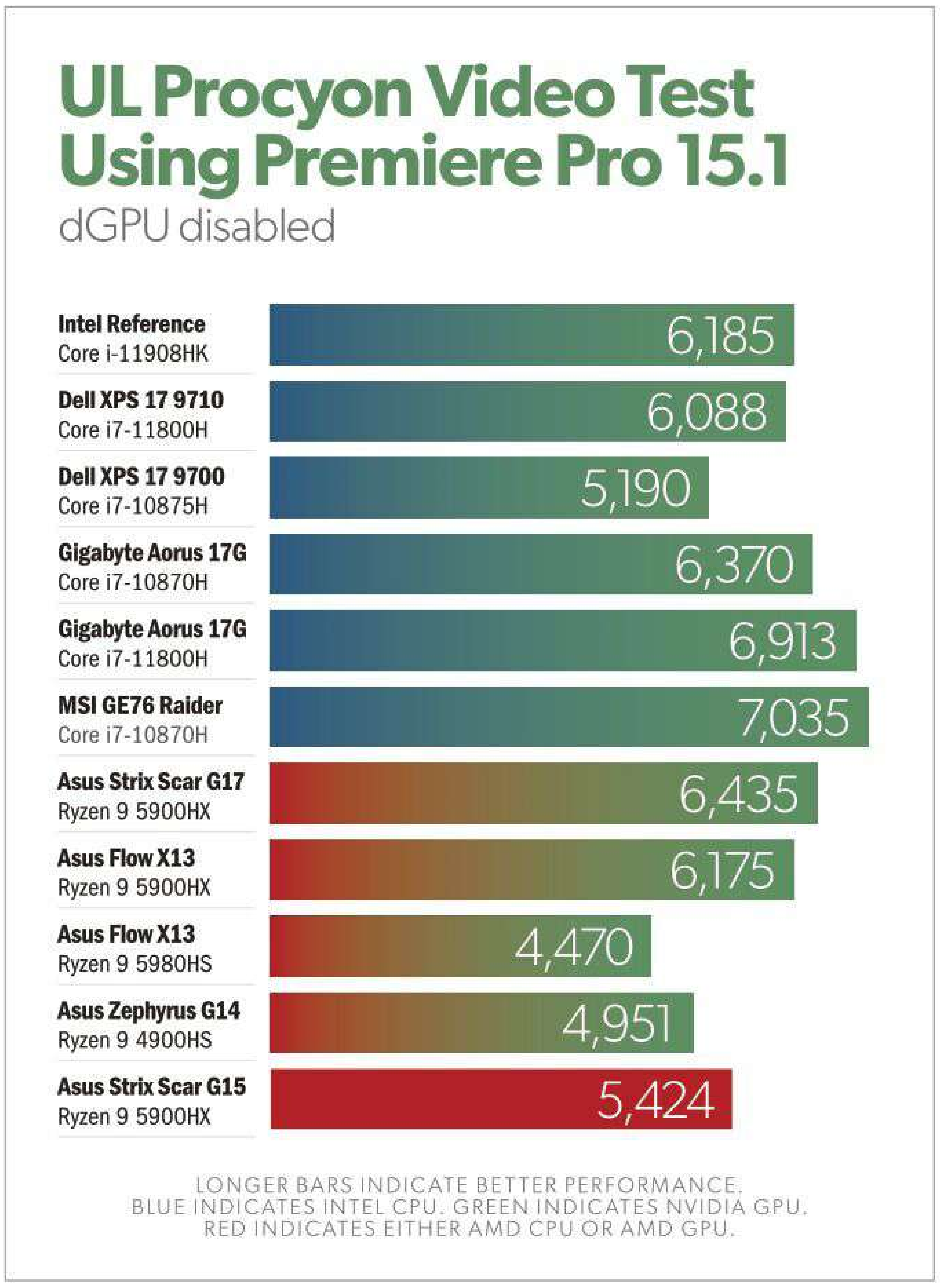
GPU PERFORMANCE

Moving on to graphics, we also run 3DMark Time Spy to gauge the GPU performance of laptops. Below, you can see the GeForce RTX 3060 Laptop at 70 watts isn't enough to win any raw gaming tests, which again tells you that you should buy a gaming laptop with a more powerful GPU if you intend to play games 90 percent of the time. The XPS 17 will play games just fine, but it's really better suited for other tasks.

In an actual game, we use *Rise of the Tomb Raider* at 1920x1080 resolution set to Very High and using DX11. Again, no surprise: Laptops with more powerful GPUs win.

If that's enough to convince you to reach for a gaming-focused laptop, instead we do





want to point out that gaming performance doesn't always translate into similar wins in applications like Adobe's Creative Cloud.

Using UL's Procyon benchmark, we run Adobe Photoshop, Lightroom Classic, and Premiere through a set of scripted tests. For the Premiere test, a video is exported from the timeline with color correction and other effects before being exported four different ways.

The fastest result comes from a high-end gaming laptop with a big fat GeForce RTX 3080 in it—but it's really only about 15 percent faster than the XPS 17 9710.

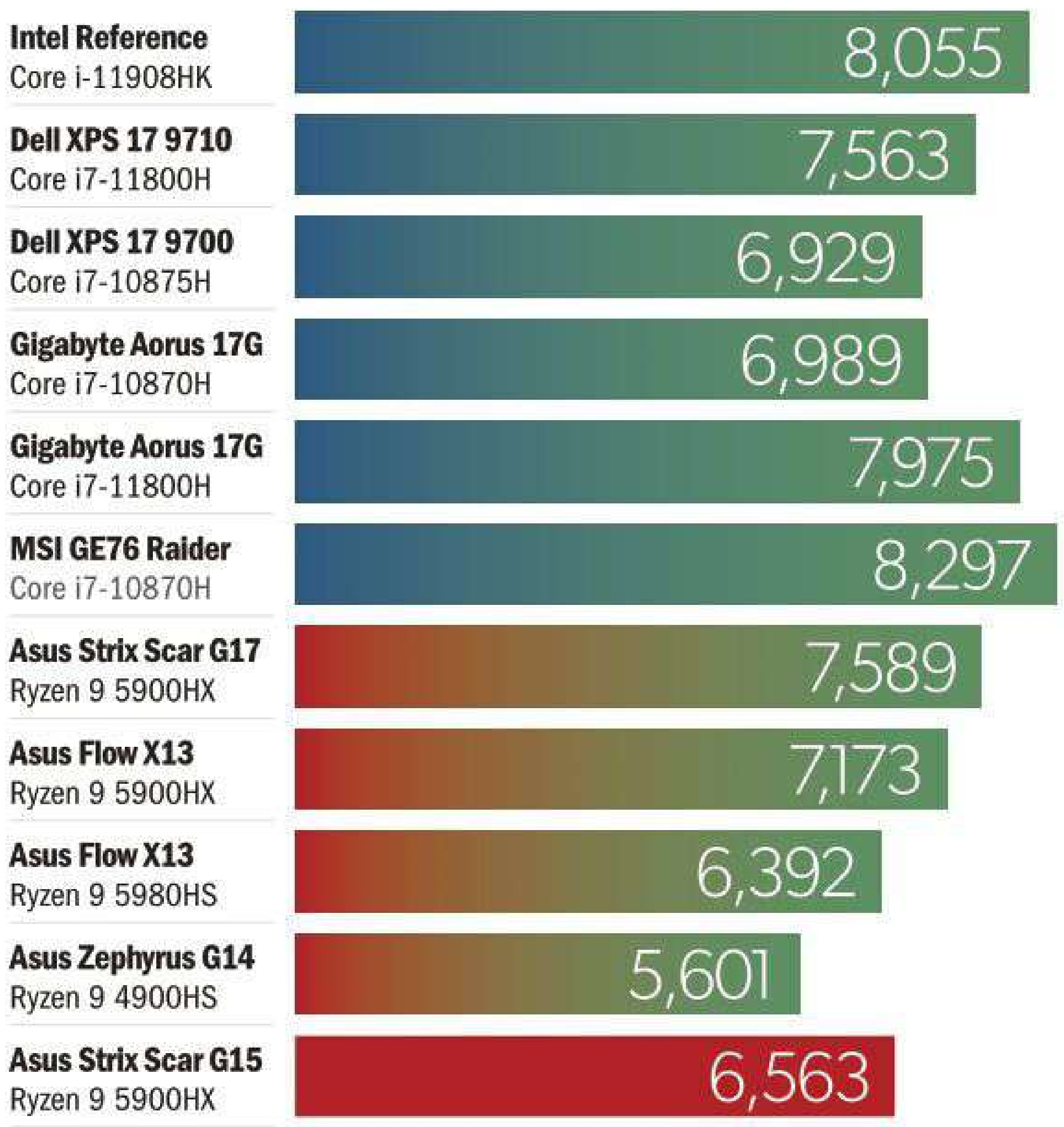
Moving to photo editing, Procyon tasks Photoshop and Lightroom Classic with editing and exporting a set of images. Unlike Premiere, which does indeed tend to use more CPU cores, many actions in Photoshop and Lightroom Classic tend to rely on fewer cores and hitting higher frequencies.

Procyon puts the XPS 17's Core i7-11800H and RTX 3060 basically on par with an Asus Strix Scar G17 with a Ryzen 9 4900HX and RTX 3080 at 130 watt TGP. The MSI GE 76 Raider—wielding a Core i9-11980HK and GeForce RTX 3080 at 165 watts—is about 10 percent faster.

Both of these tests tell us that yes, the XPS

UL Procyon Photo Test Using Photoshop 22.3/ Lightroom Classic 10.2

dGPU disabled



LONGER BARS INDICATE BETTER PERFORMANCE.
BLUE INDICATES INTEL CPU. GREEN INDICATES NVIDIA GPU.
RED INDICATES EITHER AMD CPU OR AMD GPU.

17 9710 won't run with a true gaming laptop, but if you live mostly in Adobe products, it may well be worthwhile to get a smaller laptop with a bigger screen while only giving up a little performance.

BATTERY LIFE

Our last result is perhaps the test that matters most to people: battery life. We loop a 4K video in airplane mode with earbuds in place until the battery dies. We use Windows 10's built-in Movies & TV app, which is the most efficient media player we've ever seen. With its 95 watt-hour battery, the XPS 17 9710 coughs up an impressive run time at just under 10 hours. Most gaming laptops we've seen hit around 7 hours at best—and that's with 1080p panels. Higher-resolution screens typically eat a third of battery life, so the XPS 17's performance is even more impressive.

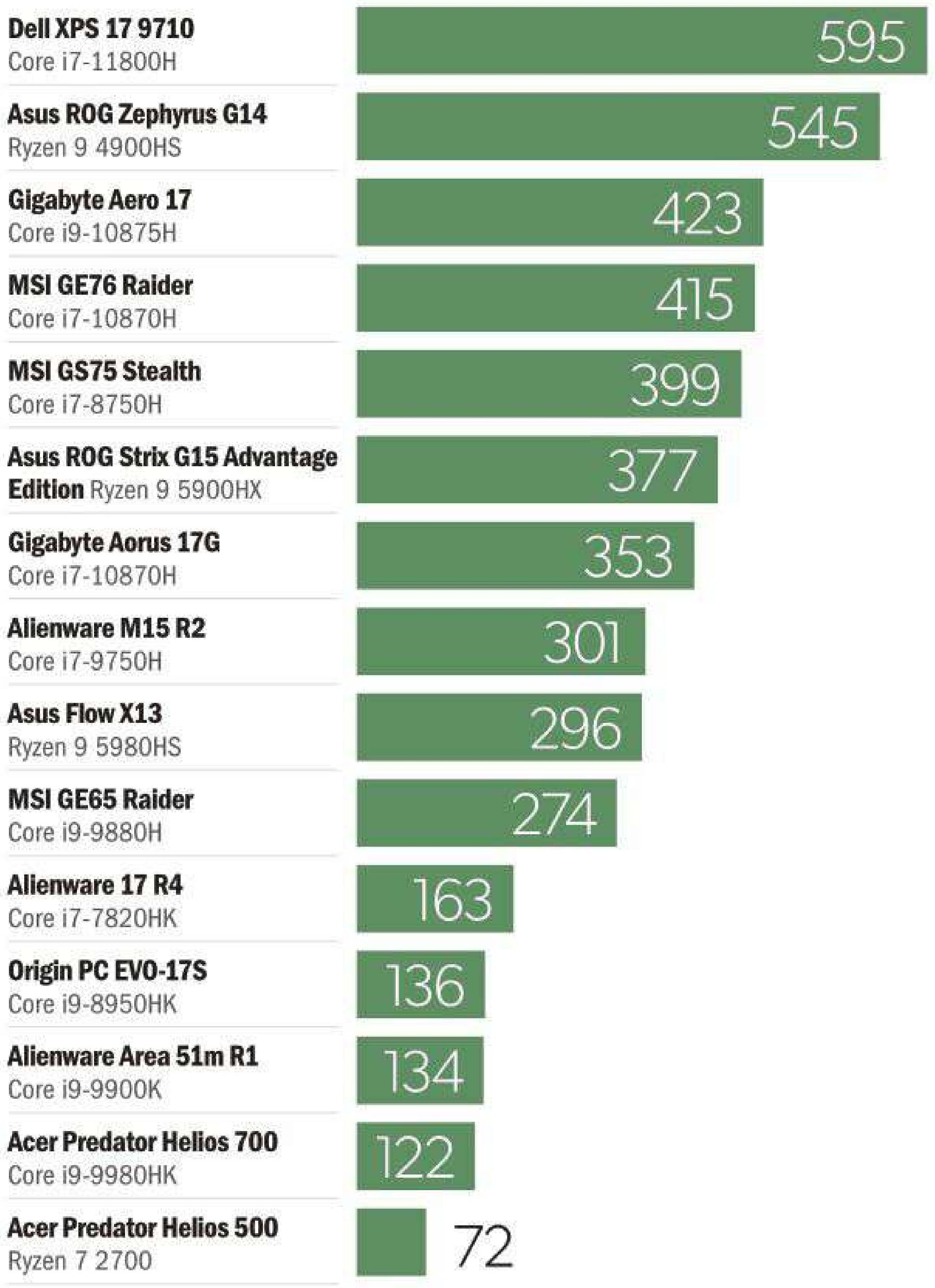
Don't think you can get 10 hours on all tasks, as video playback is basically cruising for laptops today. If you perform GPU- or CPU-intensive workloads, you should expect far shorter battery life.

HYBRID CHARGING

Before we wrap this up, we do need to touch

Battery Life

Minutes



LONGER BARS INDICATE BETTER PERFORMANCE

on one last topic: the hybrid charging system Dell uses. Basically, the concept is to use an slightly undersize power supply to charge the laptop and occasionally eat into the battery's capacity. This lets Dell do two things: Use a smaller and lighter power supply, and charge over USB-C. Typical laptops with this class of CPU and GPU use 180-watt bricks versus the 130-watt brick for the XPS 17. Those 180W bricks are typically larger and also require the use of an ugly-looking DC input or "barrel" connector.

Mind you, this was all designed well before standards were increased to 240 watts for USB-C, and we should note the 130-watt Dell brick is already beyond the maximum of 100 watts for older USB-C specs.

In practice, though, all you want to know is how far the battery drains under heavy use. It's not much. We ran the Furmark and Prime95 stress tests on the XPS 17 with its battery fully charged and didn't note any decrease in charge after 30 minutes. We also played the CPU- and GPU-intensive game *PUBG* for two hours. At one point, the battery dipped to 93 percent, but then it clawed its way back to a full charge and it never dropped again.

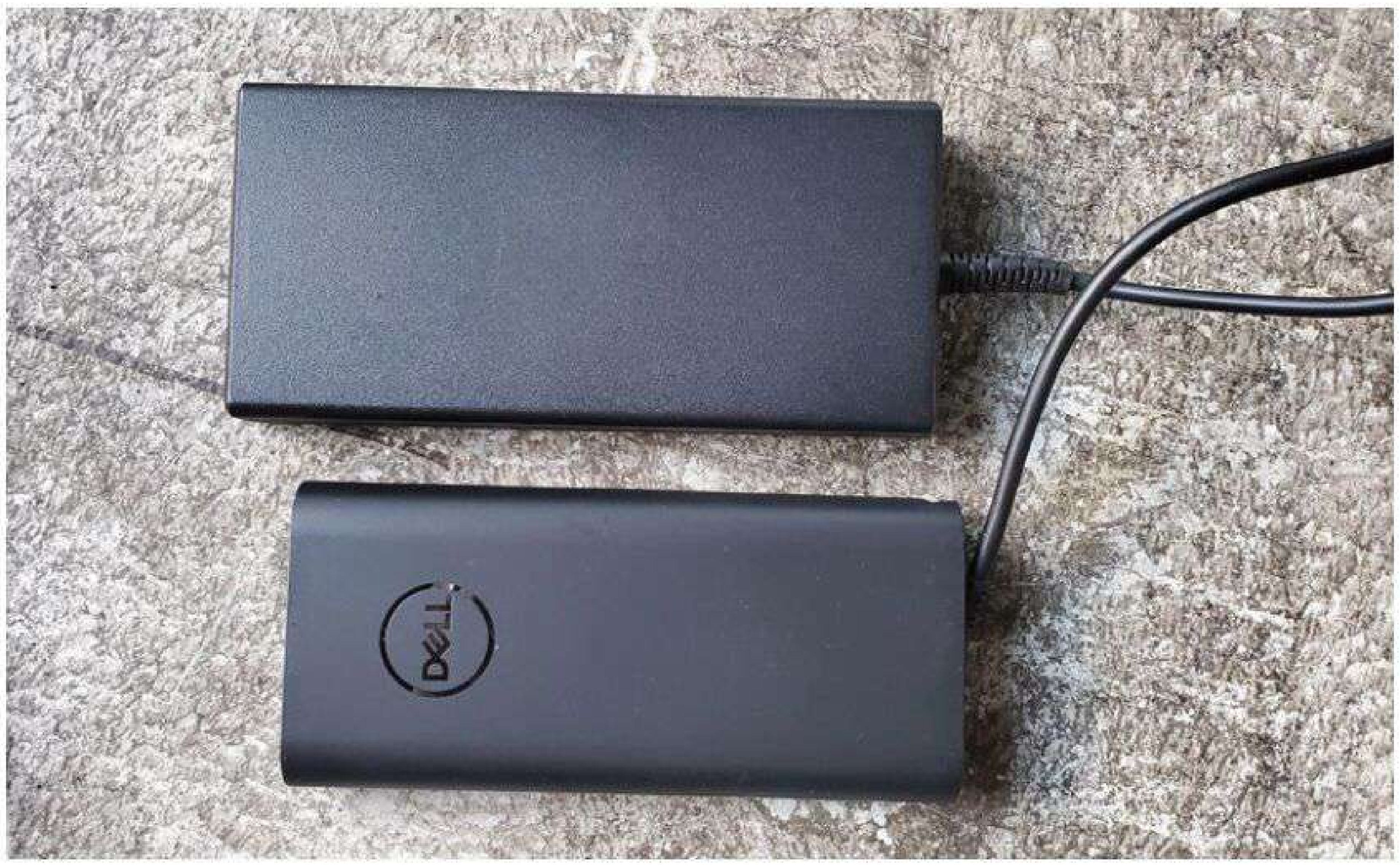
So those concerned over the battery discharge rates don't seem to have much to worry about. We understand why Dell decided to go with hybrid charging, as there are some seriously chunky 180-watt power bricks out there, and those proprietary round chargers feel 20 years out of date.

But the big question is whether it's worth the discharge concerns. In the picture above, you can see the 180-watt power brick MSI includes with its Creator Z16 laptop (top) with the Dell's 130-brick power brick below. Yes, it's true that MSI uses a funky barrel connector, but maybe it doesn't matter that much if you want to get an extra 50 watts.

Hopefully, this will just be a period of transition as we move to laptops with 240-watt USB-C power bricks in the future. For now, we're not totally sold on it being worth it, but we get why the company made the attempt.

BOTTOM LINE

We can understand why some people don't quite get why the XPS 17 even exists.



Dell's choice to use a slightly undersize 130-watt USB-C power brick (bottom) has always been somewhat controversial. Seen next to a compact 180-watt brick from an MSI Creator 16 (top).

If you want to pack the largest screen you can into the sleekest laptop possible, then the Dell XPS 17 9710 is hard to beat.

It's arguably a niche laptop that's easily outperformed by 17.3-inch gaming laptops, and on the face of it, it's only one-inch larger than 16-inch laptops.

The truth is the XPS 17 actually threads that needle quite well. You're getting the maximum amount of screen real estate in a laptop, but in a package that's just an inch wider than most thin 15.6-inch gaming laptops. Even against the new crop of 16-inch laptops, you're still getting a considerable amount of additional screen real estate.

In addition to giving you slightly more screen, the Dell XPS 17 9710 is also considerably less bulky than 17.3-inch gaming laptops. Yes, its RTX 3060 can't run with an RTX 3080—but the fact is, most Adobe applications quickly hit diminishing returns beyond an RTX 3060, so why carry that thick 17.3-inch gaming laptop around with its 2.5-pound brick if all you're getting is a 15 percent improvement in performance?

To sum up, if you want to pack the largest screen you can into the sleekest laptop possible, and you spend a big chunk of time running Adobe apps, it would be pretty hard to beat the XPS 17 9710. Sure, that's definitely a niche, but it's not a bad niche to be in.

Dell XPS 17 9710

★★★★☆

PROS

- Huge 17-inch screen in a relatively compact laptop.
- Intel's newest 11th-gen CPU and Nvidia RTX graphics.

CONS

- No USB-A port and no Gigabit Ethernet.
- Hybrid charging likely sacrifices a little performance.

BOTTOM LINE

Dell's XPS 17 9710 features Intel's impressive 11th-gen CPU along with an Nvidia GeForce RTX 3060 Laptop GPU and a huge 17-inch screen.

$2,939

Crucial P5 Plus: A fast PCIe 4 SSD with tough competition

This follow-on to the affordable and speedy P5 is (slightly) faster and supports PCIe 4, but it's also significantly pricier. **BY JON L. JACOBI**

crucial
P5 Plus M.2 2280
OF GAMERS

The P5 Plus is the follow-on to Crucial's affordable and surprisingly fast P5 NVMe SSD (go.pcworld.com/crp5). It's a worthy encore, at least in terms of performance. Not only is this new version slightly faster, it offers the PCIe 4 support the older drive lacks. Alas, that slight uptick in performance and the PCIe 4 support also come with a significant price bump, putting it in direct competition with Samsung's excellent 980 Pro (go.pcworld.com/980p).

Note that Crucial has come under fire for switching from TLC to far slower QLC in its P2 SSD without changing the name. Should your P5 not perform up to our numbers, let us know.

DESIGN AND FEATURES

The Crucial P5 Plus comes in at $108 for 500GB (go.pcworld.com/c50g), $180 for 1TB, what we tested (go.pcworld.com/c1tb), and $367 for 2TB (go.pcworld.com/c2tb) flavors. The PCIe 4.0, x4 SSD uses the standard 2280 (22mm wide, 80mm long) form factor and employs 176-layer, TLC (Triple-Level Cell/3-bit) NAND with an in-house Micron controller.

IMAGE: CRUCIAL

The Crucial P5 Plus is warrantied for five years, as well as rated for 300TBW (terabytes that can be written) per 500GB of capacity. That's in line with the drive's price. Though essentially the same as pro drives, consumer drives are expected to see less use and are priced accordingly. They carry lower ratings, which will mitigate the warranty, to discourage high-transaction use in servers and other intense endeavors. That said, most users will never write nearly as much data as even bargain drives are rated for.

I have to mention Crucial including an M.2 mounting screw in the box. Losing those little suckers has been a problem as long as I've been testing the type. Nice touch.

PERFORMANCE

Because of the older P5's surprisingly fast performance, the good numbers turned in by the 1TB P5 Plus that Crucial sent were hardly unexpected. In general, it outpaced its predecessor by about 5 to 10 percent. Massive 450GB writes slowed down by a third once they got about two-thirds into the operation, and peak PCIe 4 write speed wasn't rated top-tier by synthetic benchmarks. Other than that, especially in real-life transfers, it was all good.

CrystalDiskMark 6 was slightly pessimistic about the P5 Plus's write speed over PCIe 4 compared to the other drives. However, 5GBps is still a very nice boost over PCIe 3—the non-Plus P5 topped out at 3.3GBps over that interface, as does the P5 Plus when you plug it into a PCI 3 system.

As noted, the Crucial P5 Plus's real-world sustained reads and writes (shown below) were very good. It lost to the top-ranked Seagate FireCuda 530 and aforementioned Samsung 980 Pro, but not by a large margin.

The P5 Plus lost half a star in our final rating due to a drop in write speed during our long 450GB write, which we run to show where drives run out of main cache as well as the native speed of the NAND. Main cache (not DRAM) is NAND treated as SLC (Single Level Cell). Writing a single bit is far faster than writing three as you would do natively with TLC NAND. Contents of the cache are transferred to three bits when the drive has time.

For the 1TB P5 Plus tested, cache ran out at around the 315GB mark of our 450GB

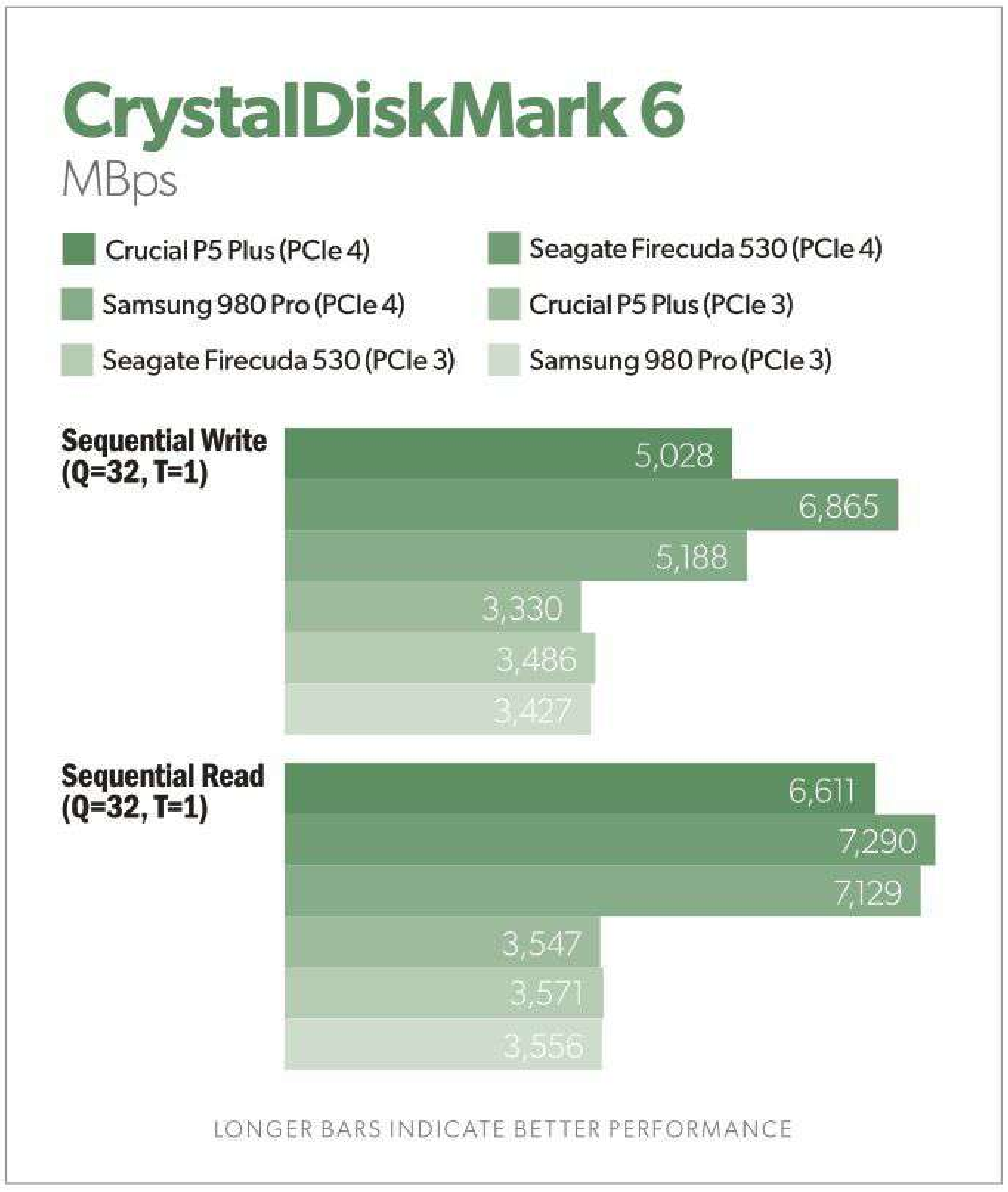
crucial
by Micron
P5 Plus M.2 2280

Crucial sent us this image of the speedy P5 Plus, which illustrates the 2280 form factor perfectly.

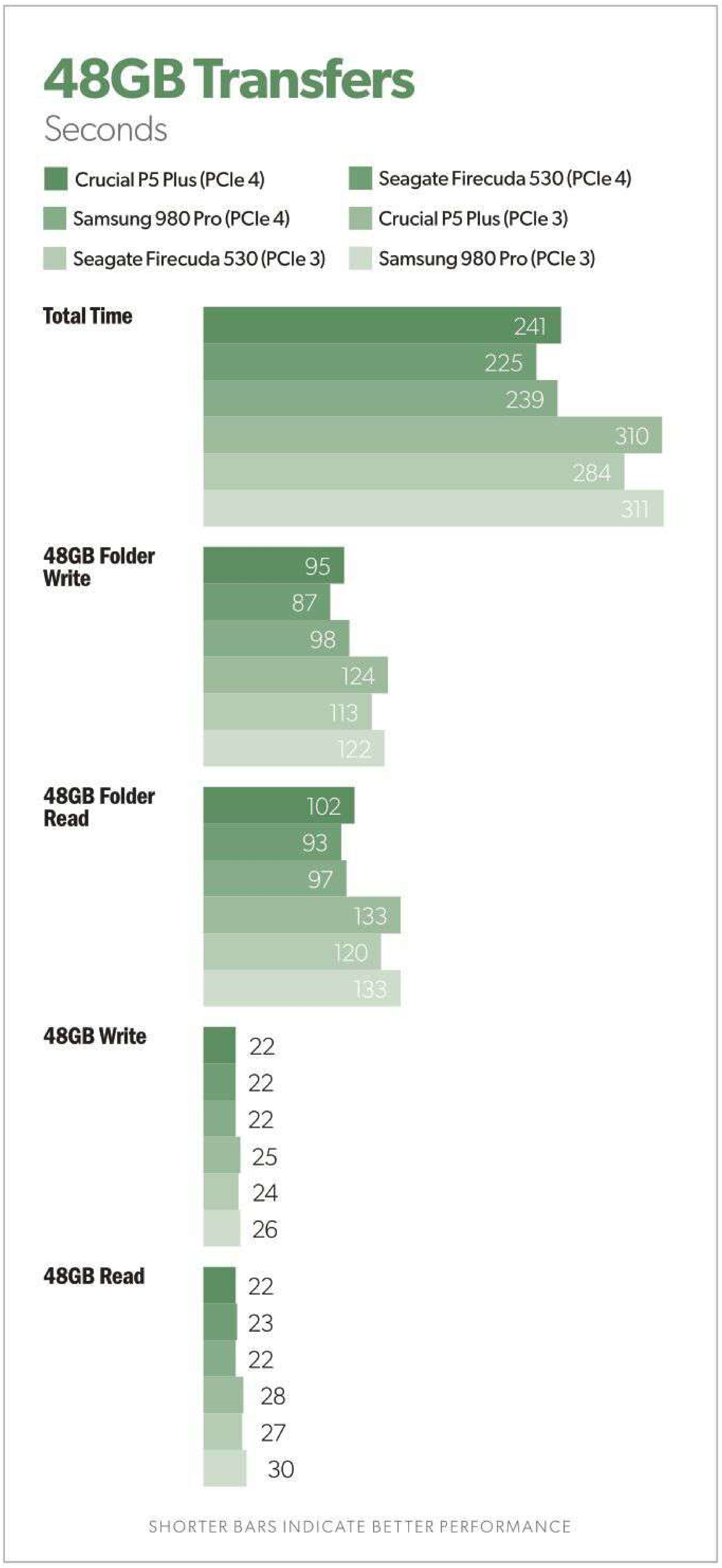
write test. The 500GB capacity will likely run out sooner and turn in slower times, while the 2TB capacity will probably not run out at all and shave a hundred seconds off the times shown above. Slowdowns somewhere during this test are the general rule for second-tier or lower drives—Kingston's KC2500 (go.pcworld.com/kn25) excepted. As to the meaningfulness of this test, most normal users will rarely if ever move more than 315GB of data in one go.

All in all, the Crucial P5 Pro is a very good performer in just about every scenario the average user is likely to experience.

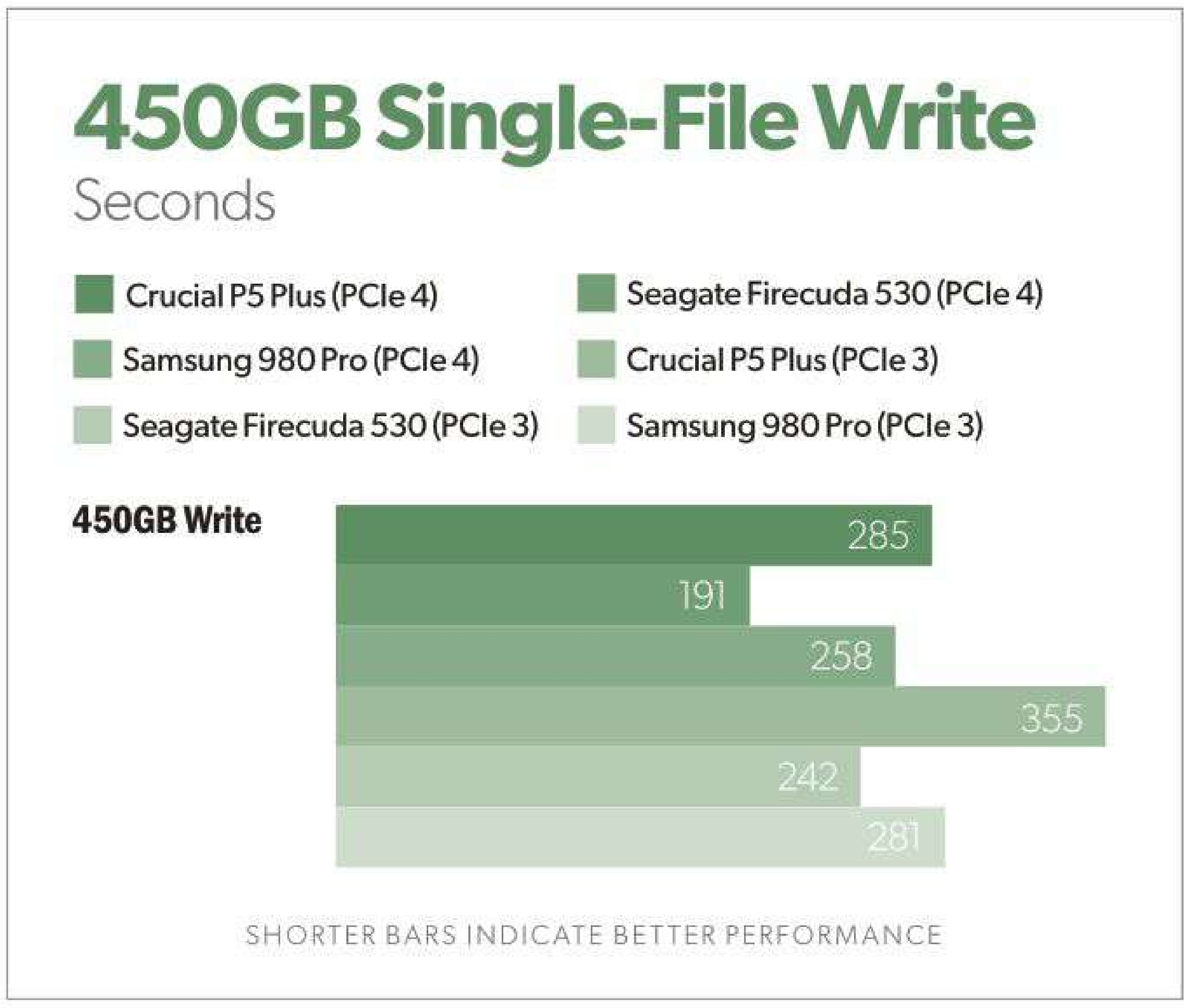
The PCIe 3 tests utilized Windows 10 64-bit running on a Core i7-5820K/Asus X99 Deluxe system with four 16GB



The Crucial P5 Plus can't quite keep up with the better drives in synthetic benchmarks such as CrystalDiskMark 6, but it's still a dramatic improvement over PCIe 3.



Real-world performance leveled the playing field slightly, with the P5 Plus only losing to Seagate's best-of-breed FireCuda 530 (go.pcworld.com/fcda) and the Samsung 980 Pro by a small margin.

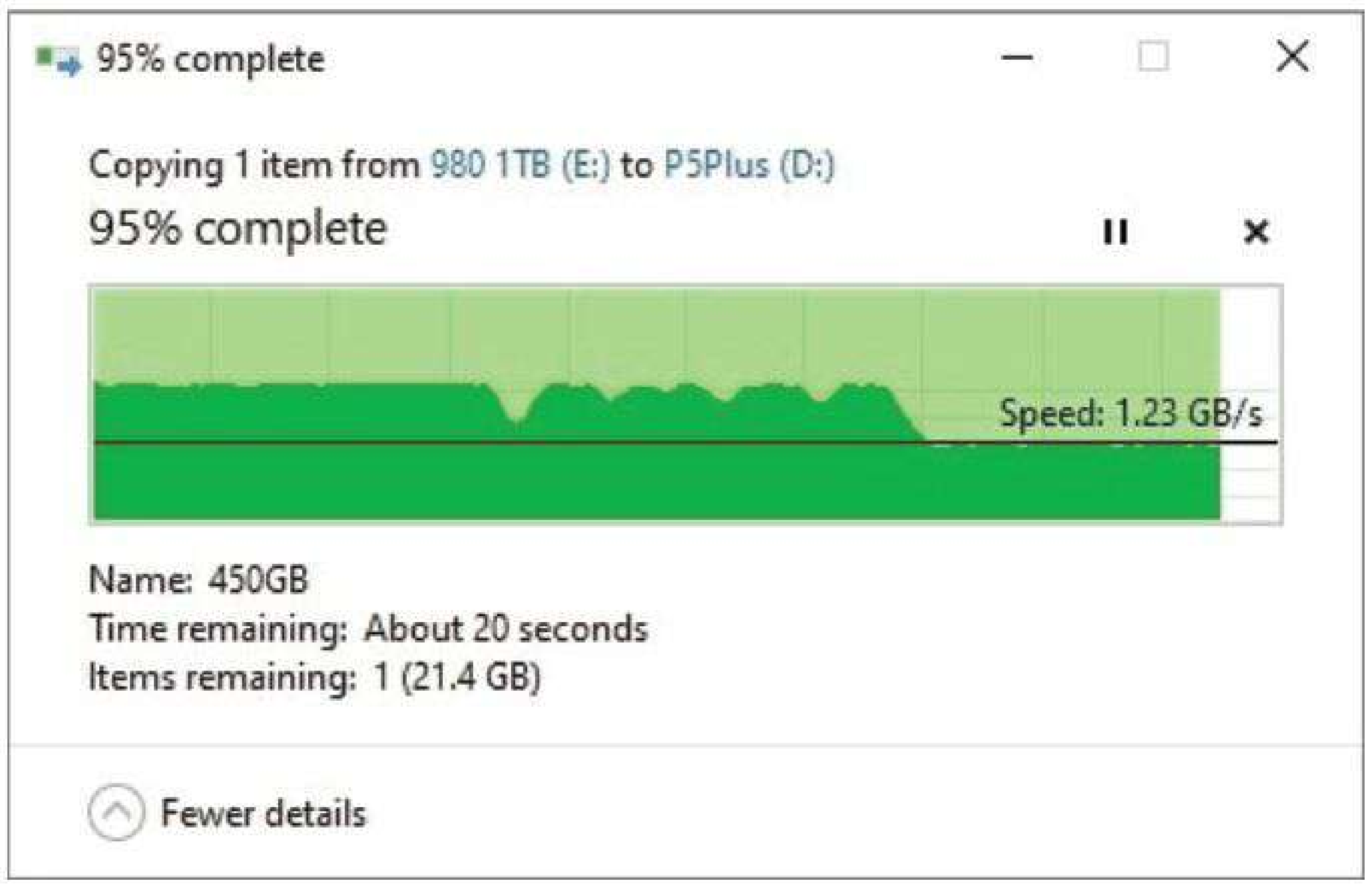


Where the Crucial P5 Plus really showed its low-cost nature was in our long 450GB write. Up to about 315GB it was as fast as the rest, but then it throttled down as it ran out of cache.

Kingston 2666MHz DDR4 modules, a Zotac (NVidia) GT 710 1GB x2 PCIe graphics card, and an Asmedia ASM3242 USB 3.2x2 card. It also contains a Gigabyte GC-Alpine Thunderbolt 3 card, and Softperfect Ramdisk 3.4.6 for the 48GB read and write tests.

The PCIe 4 testing was done on an MSI MEG X570 motherboard socketing an AMD Ryzen 7 3700X 8-core CPU, using the same Kingston DRAM, cards, and software. All testing is performed on an empty or nearly empty drive that's TRIM'd after every set of tests. Performance will decrease as the drive fills up.

If your performance varies drastically from what we found with our review drive, please let us know.


95% complete

Copying 1 item from 980 1TB (E:) to P5Plus (D:)

95% complete

Speed: 1.23 GB/s

Name: 450GB

Time remaining: About 20 seconds

Items remaining: 1 (21.4 GB)

Here you can see the P5 Plus running out of cache at around the 315GB mark in a 450GB write.

BOTTOM LINE

The P5 Plus is a very good NVMe SSD, but it's not the bargain its predecessor was. I still recommend the older drive for PCIe 3 users seeking to save money, but at the time of this writing, the more consistent-performing Samsung 980 Pro (go.pcworld.com/980p) is priced lower than the P5 Plus. That makes the P5 Plus a bit of a tough sell.

Crucial P5 Plus

★★★★☆

PROS

- Excellent everyday performance.
- Great bang for the buck.

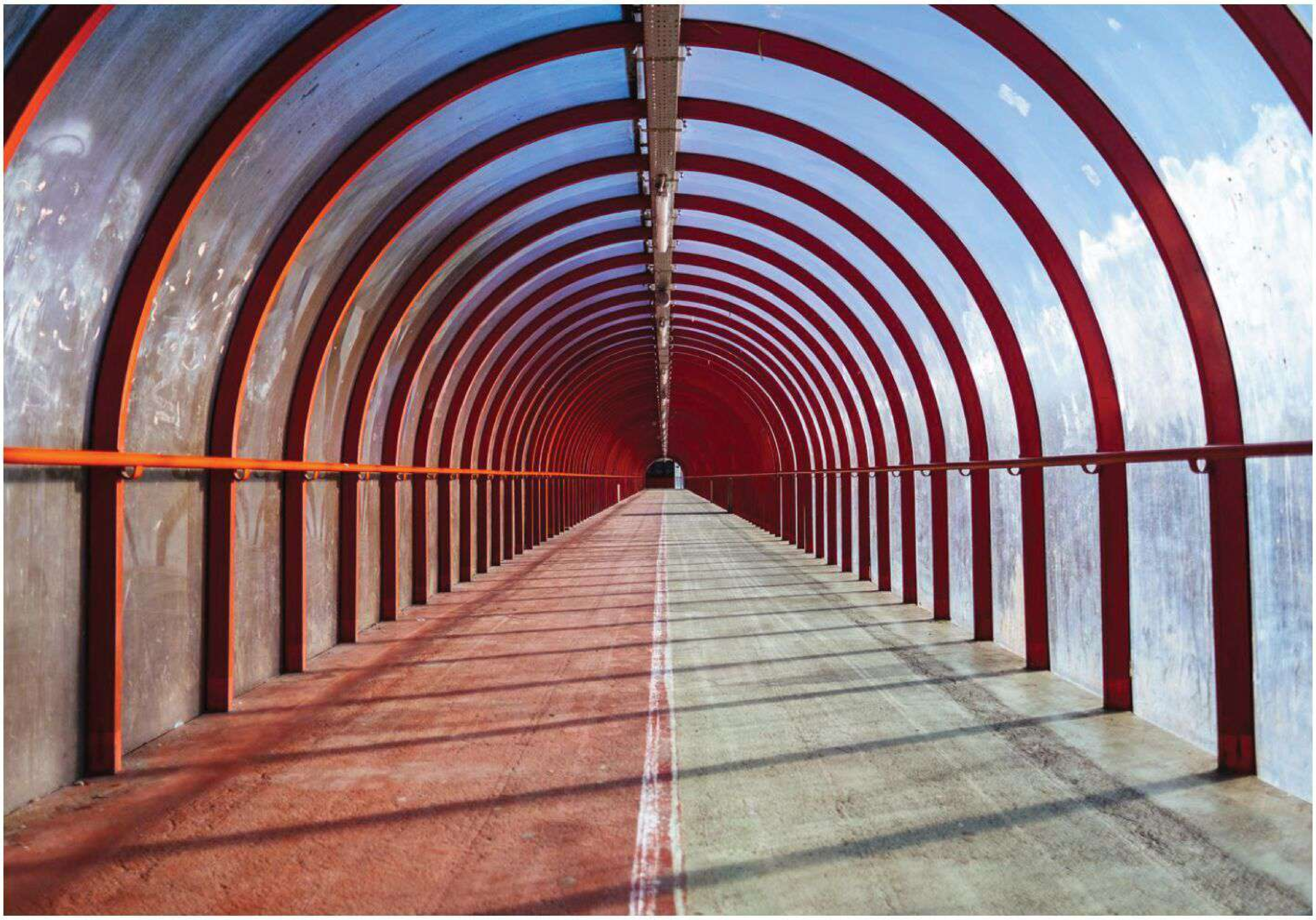
CONS

- Slows down on very long writes.

BOTTOM LINE

The Plus version of the P5 now supports PCIe 4, so users with the more modern bus can benefit from the increased bandwidth. However, while it's a very good NVMe SSD, at the time of our review it was priced higher than several worthy competitors, including Samsung's excellent 980 Pro.

$169



Mullvad VPN: Our favorite ultra-private VPN gets even better

Mullvad adds a few useful extras, as well as a big expansion of its network of servers.

BY IAN PAUL

PCWorld EDITORS' CHOICE

For a long time Mullvad has been a solid VPN service that didn't change a whole lot other than adding an improved app. It continues to use the improved VPN app that we saw roll out several years ago, but the company is also adding new features and dramatically expanding its network compared to what we saw last time around.

Despite the changes, Mullvad's greatest strength is still that it prefers to know as little about you as possible, which is a huge win for anyone trying to stay as anonymous as possible online. The company doesn't even want to retain your email address—whether

IMAGE: UNSPLASH

that's a primary address or a "burner" one only for VPNs. Instead, Mullvad issues each user an account number—current numbers are about 16 characters long. The company's attitude seems to be that the less it knows about you, the better.

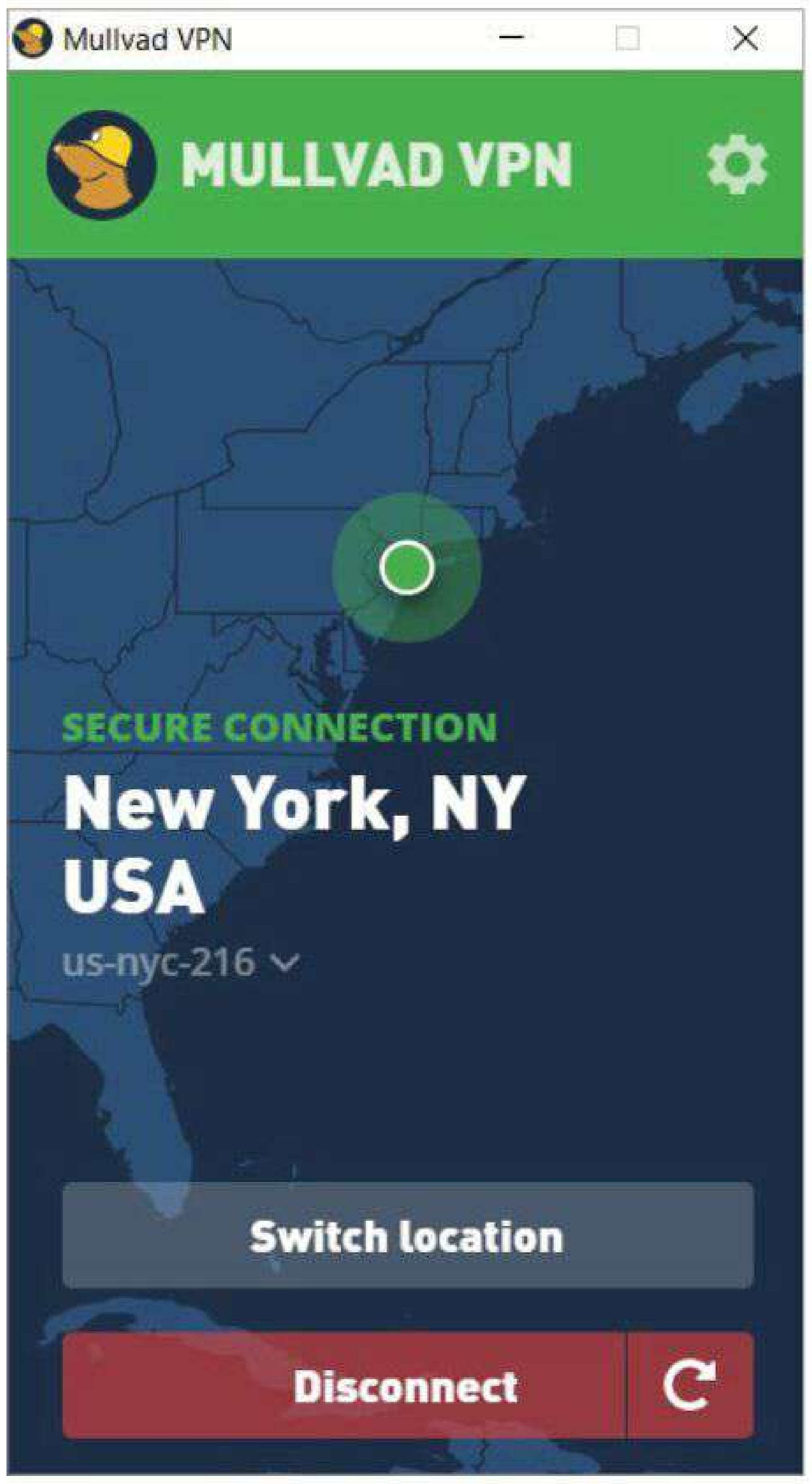
Mullvad's app looks modern and clean, and very much like a Windows Store app. It starts with a non-interactive map in the primary section of the window to show which location you're connected to, or your default location at the country level.

When you've connected, you'll see a Switch location and Disconnect button at the bottom of the window. The top of the screen, meanwhile, shows a green banner with the Mullvad VPN logo indicating that you're connected.

Click the Disconnect button and Mullvad shows your true location, the top goes from green to red, and the buttons at the bottom are labeled as the last country you connected to and "Secure my connection."

If you jump into the country listings, you can select a country, select a specific location within the country if more than one is available, and drill down to individual servers. The app doesn't show any specific metrics about each server, such as ping times or load, but if there's a red circle next to a server, that means it's not available for use. Green, meanwhile, means it's working.

The app is very easy to read and understand. It's not a free-moving window by default. Instead, it's a panel that's permanently fixed to the bottom-right corner of the screen. There's enough space so it doesn't feel constrained sitting there. If you don't like that, however, Mullvad allows you to undock the app and move it around like a normal window. To do so, select the settings cog at the top right of the window and then go to Preferences > Unpin app from taskbar.



An active connection shown in Mullvad for Windows.

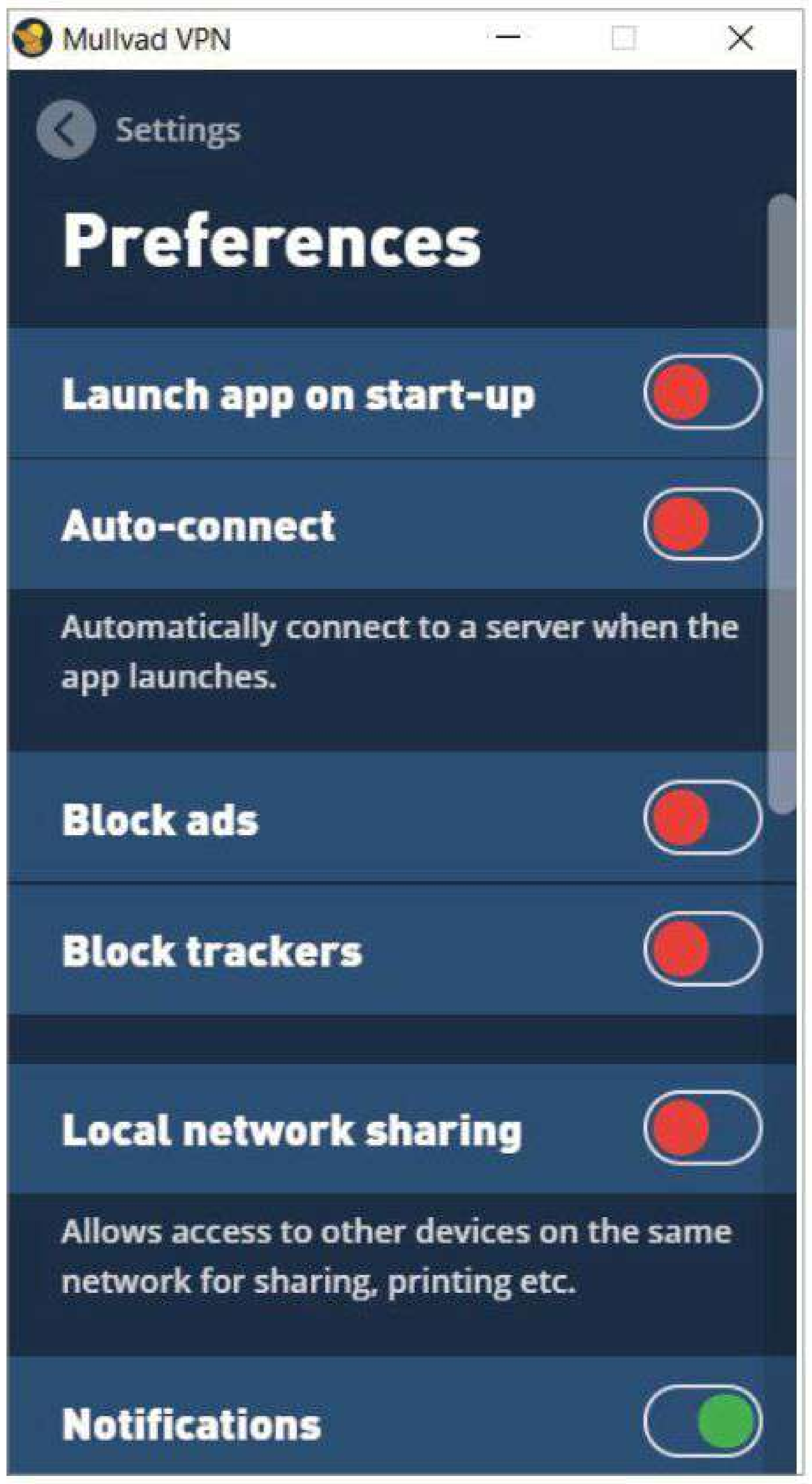
FEATURES AND SERVICES

Mullvad traditionally hasn't been big on extra features or services compared to other VPNs. It doesn't promise to get past Netflix VPN restrictions (though sometimes it does) and it doesn't have any double-hop connections or smart DNS. However, it has added a few extra features recently. Mullvad recently introduced DNS-based ad and tracker blocking inside the desktop app. These features aren't activated by default. To turn them on, you need to select Settings > Preferences > Block ads and Preferences > Block trackers. If you'd like to read about how Mullvad implements ad blocking, check out the blog post on the company's site (go.pcworld.com/imad). The long and short of it is that the new DNS blocking doesn't substantially change how its service is configured and therefore doesn't affect Mullvad's privacy promises.

Mullvad has also added split tunneling, which allows some apps to operate over the VPN, while others don't. Split tunneling is a beta feature, but if you want to use it, go to Settings > Advanced > Split tunneling.

You'll find a few other options in the settings. Under Settings > Preferences, there are options to autoconnect when Windows starts, or to automatically connect when you open Mullvad. Both are off by default. Under this section, you can also enable your PC's sharing options, even though you're on a VPN. You can also opt to use a monochromatic tray icon if you have visual needs, as well as to start Mullvad minimized and to sign up for Mullvad's beta program.

Go to Settings > Advanced, and you can enable Mullvad's IPv6 option, as well as manually choose between using OpenVPN or WireGuard. Mullvad was one of the earliest VPN services to implement WireGuard.



Preferences

Launch app on start-up

Auto-connect

Automatically connect to a server when the app launches.

Block ads

Block trackers

Local network sharing

Allows access to other devices on the same network for sharing, printing etc.

Notifications

Mullvad's Preferences options.

Another nice tool to use with the VPN is Mullvad's connection check webpage (go.pcworld.com/cnch). It lets you know whether the app is working and currently connected to Mullvad. It also checks to see if you are leaking DNS requests, suffering from a WebRTC leak, or using a blacklisted IP address.

Mullvad has apps for Windows, Mac, Linux, iOS, and Android.

PERFORMANCE

Mullvad's number of servers and country locations has increased since our last review, while its performance has remained solidly the same. That's great news since Mullvad was already one of the standouts. The company now covers 38 different countries (35 over OpenVPN), with a staggering 780 servers. That is a massive increase considering Mullvad only had 304 last time we looked.

Mullvad's change is largely thanks to its decision to start renting servers (actual boxes, not virtual servers) instead of owning every single piece of equipment that runs its VPN. Mullvad explains in clear terms on its help pages what the differences are between rented and owned servers (go.pcworld.com/mvhp). You can see which servers Mullvad owns and which it rents on its Servers page (go.pcworld.com/mvsp).

For this round of testing, we tested both OpenVPN and WireGuard performance to see if there was any difference on Windows. OpenVPN performed better than WireGuard in our testing, which takes the average performance of connections to five different countries over three days of testing with multiple runs.

Using OpenVPN, Mullvad retained close to 39 percent of the base speed. That's not quite as strong as what we saw last time, but it's still good enough to put Mullvad in the top 10 for speed, though just barely. Mullvad using WireGuard was a little slower around 35 percent of the base speed.

Speeds were particularly strong in Germany and the UK, coming incredibly close to the base speeds, often within 10-15Mb/s over OpenVPN. WireGuard had similar results, although they were less consistent than OpenVPN's.

The bottom line is that overall, you should be happy with the speeds from Mullvad, with the usual caveat that your experience may vary depending on your location in the world, equipment, and ISP.

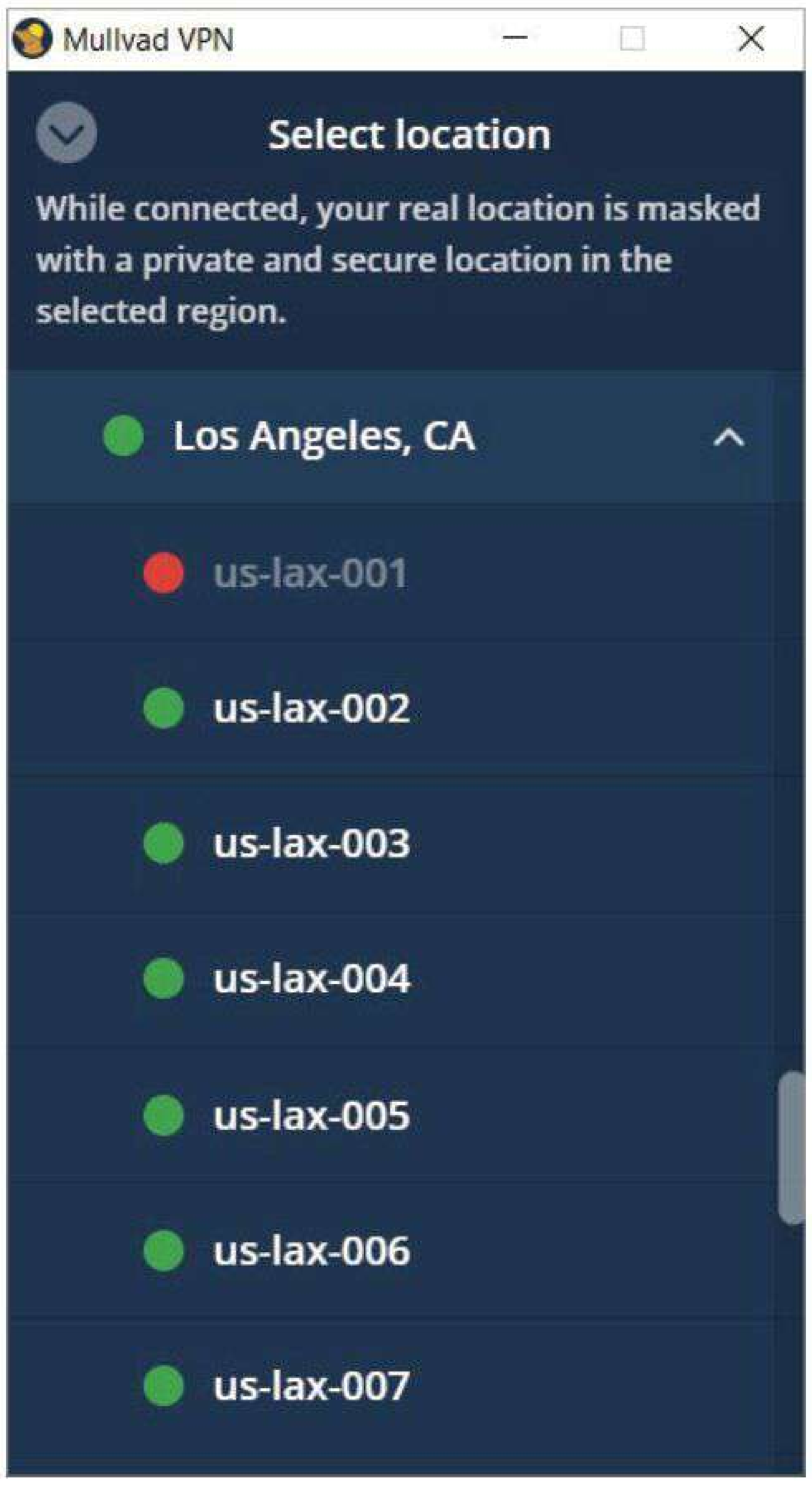
PRIVACY, ANONYMITY, AND TRUST

Mullvad's privacy policy is exactly what you're looking for in a VPN. Though it has now been split into two different documents: the general privacy policy (go.pcworld.com/mulp) and the "no-logging of user activity policy" (go.pcworld.com/nlog). In those two documents the company says it does not "store any activity logs or metadata." There's no logging of your online traffic, DNS requests, connections, timestamps, IP addresses, bandwidth, nothing. The server logs are sent to /dev/null, a nonexistent directory on Linux machines. In other words, the logs are automatically sent into the ether.

The only data Mullvad saves is the total number of current connections of all users on its network, the CPU load per core on its servers, and the total bandwidth used per server. It also logs the real-time number of connections per account, as the service allows five simultaneous ones for each account.

The company also takes the time to explain how much privacy you should expect

Mullvad's location listings at the server level.



Select location

While connected, your real location is masked with a private and secure location in the selected region.

- Los Angeles, CA
  - us-lax-001
  - us-lax-002
  - us-lax-003
  - us-lax-004
  - us-lax-005
  - us-lax-006
  - us-lax-007

from Mullvad based on the VPN protocol you use and the payment type you use.

If you mail cash, for example, Mullvad says it will take the cash, add credits to the account number included in the envelope, and then shred the envelope and the note. If you choose to use credit cards or PayPal, however, you will be identifiable through those payment services. Mullvad accepts cash, cryptocurrencies, credit cards, bank wires, Swish (a Swedish mobile payment service), and PayPal.

As for the Mullvad website servers, all logs are stored for up to 5 minutes. Mullvad's website cookies also expire pretty quickly. You can read about that in more detail on the company's cookie policy page (go.pcworld.com/mlck).

Mullvad is owned by Amagicom AB and based in Sweden. The company CEO is Jan Jonsson, and the co-founders are Fredrik Strömberg and Daniel Berntsson.

BOTTOM LINE

It's good to see Mullvad adding new features that enhance privacy and security, and this expansion of its network means it's easy to get a solid connection without too many maxed-out servers. With its continuing commitment to privacy and anonymity (at least as close as you can realistically get online), as well as performance, Mullvad remains one of our top recommendations.

Mullvad VPN

★★★★½

PROS
- Good speeds.
- Higher level of anonymity possible than with most VPN services.
- Windows desktop is easy to use.

CONS
- Not guaranteed to work with Netflix.
- Lacks the extra services some VPNs offer.
- No password protection for your account.

BOTTOM LINE

Sweden-based Mullvad is like the Swiss bank account of VPNs. Instead of attaching your account to an email address, the company auto-generates an account number for you, which is all that's required to log in. Mullvad offers a user-friendly interface; its speeds are good; it supports ad blocking; its server network is expanding; and the company takes privacy very seriously.

$5.86 per month

Acer Swift X: A rare ultraportable laptop with bite

It stumbles in some fit-and-finish details, however. **BY MATT ELLIOTT**

The Acer Swift X packs impressive power inside an ultraportable case and is a great pick if you want a high-performance, highly portable laptop. Where most ultraportables prize efficiency and rely on integrated graphics, the Swift X serves up Nvidia's GeForce RTX 3050 Ti GPU for an added punch. With the RTX graphics and a powerful AMD CPU, the Swift X is able to handle content-creation tasks and some gaming in addition to the basic office chores for which most ultraportables are built.

The Swift X doesn't toss efficiency out the window and it provides ample battery life despite its power-hungry parts. You'll need to put up with a frequently loud fan and warm

IMAGE: ACER

keyboard, however, and the system's fit and finish is not on par with that of other premium ultraportables. Make sure you need the graphics prowess of the Swift X before committing to this system, because you are forced to sacrifice in other areas to get it.

SPECIFICATIONS

Acer currently sells only one model of the Swift X. It's a 14-inch laptop based on an AMD Ryzen 7 5800U CPU and RTX 3050 Ti graphics with a list price of $1,099.99 (go.pcworld.com/sxlp). It's currently selling for $1,069.99 on Amazon (go.pcworld.com/sxam). Let's take a look at the specifications of the Swift X (model SFX14-41G-R1S6) that we reviewed:

CPU: 8-core, 16-thread AMD Ryzen 7 5800U

Memory: 16GB

Graphics: Nvidia GeForce RTX 3050 Ti

Storage: 512GB PCIe NVMe M.2 SSD

Display: 14-inch, 1920x1080 IPS nontouch

Webcam: 720p

Connectivity: Left: 1 x SuperSpeed USB 10Gbps Type-C, 1 x SuperSpeed USB 5Gbps Type-A (with power-off charging), HDMI 2.0; right: 1 x SuperSpeed USB 5Gbps Type-A, combo audio jack

Networking: Wi-Fi 6, Bluetooth 5.2

Biometrics: Fingerprint reader

Battery capacity: 58.7 Watt-hours

Dimensions: 12.71x8.35x0.7 inches

Measured weight: 3.1 pounds (laptop), 0.9 pounds (AC adapter)

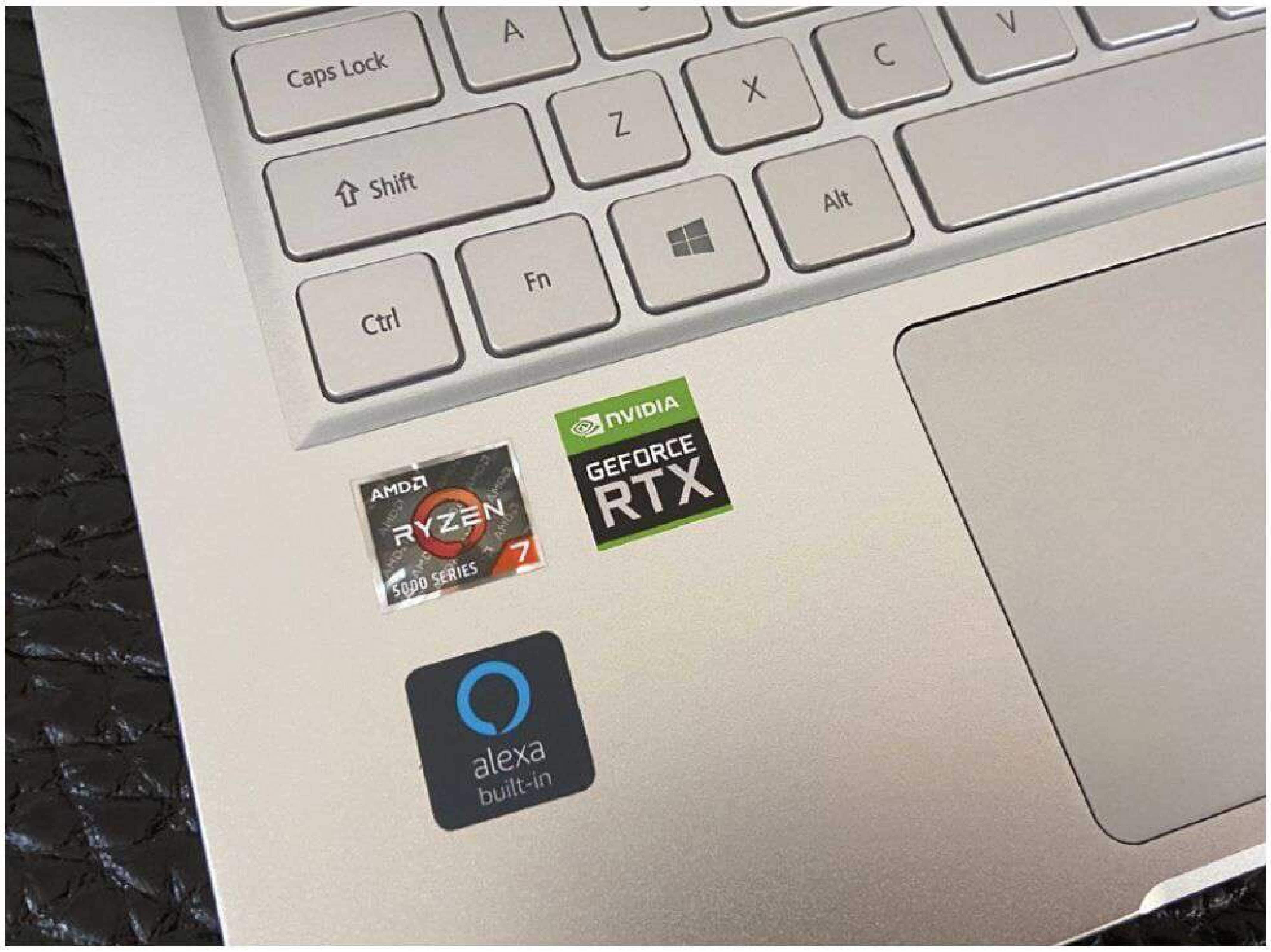
GOLD-AND-SILVER DESIGN

The Swift X features a thin aluminum chassis that's available in three colors: Steam Blue, Prodigy Pink, and Safari Gold. We received the gold model, but only parts of the laptop come draped in the hue: the lid, a narrow strip above the keyboard, and the display hinges. The rest of the laptop is silver in color, resulting in a two-tone look that lends

an OEM feel to the system. The matte-black plastic display bezels also earn the system a design demerit.

The aluminum chassis is quite compact. It's roughly the same size as another high-powered 14-inch laptop, the HP Envy 14 (go.pcworld.com/env4). Both are only 0.7 inches thick, and the Swift X, at 3.1 pounds, is a few ounces lighter than the 3.3-pound Envy 14. The Swift X's power brick is also compact, resulting in a reasonable and eminently portable total carrying weight of just 4 pounds.

When you open the display, the hinges dip down below the bottom panel to provide a slight tilt of the keyboard for a more comfortable typing angle and to improve airflow. With its high-end components packed into such a compact enclosure, the Swift X needs all the aid it can get to keep thermals in check. The laptop is fairly quiet during basic tasks, but the cooling fan really begins to spin when it's engaged in heavier lifting. While running Photoshop and other graphics apps or during



games, the Swift X gets loud. And even with its cooling fan working overtime, the laptop begins to heat up to the point where the keys feel rather toasty under your fingertips.

The keys themselves feel snappy and sound quiet, but two things annoy me about the keyboard. For one, the keys are silver instead of black, which leaves little to no contrast when the keyboard backlighting is on and you are sitting in a room that's not completely dark.

For another, the Page-up and Page-down keys are squeezed in above the side arrow keys, and I hit them constantly by accident. I'd much rather have these keys mapped to another key or placed anywhere else besides their current spot. Below the arrow keys is a fingerprint reader for easy, secure logins. The webcam lacks IR capability, so the fingerprint reader is the only biometric option on the Swift X.

The touchpad felt accurate, with smooth gliding and a firm, responsive click. I have no issues with the touchpad, but I do have a gripe about the AMD, Nvidia, and Alexa stickers to its left. They are placed in such a haphazard fashion that their crooked and ill-spaced positioning

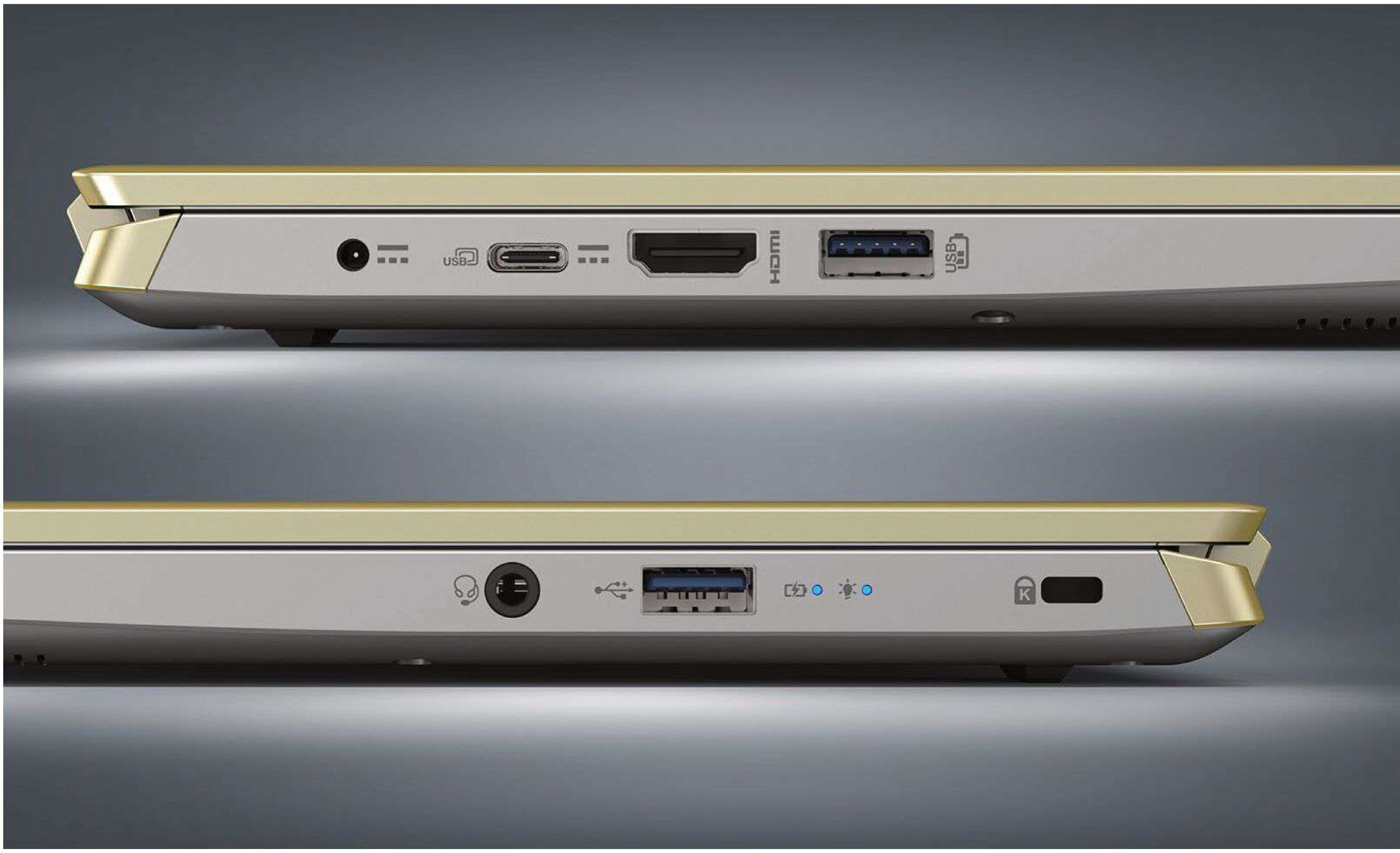
detracts from the Swift X's overall appearance. Acer's sticker affixer needs to get it together.

SQUEEZED BY 16:9 PANEL

The 14-inch display features a full HD (1920x1080) resolution and 100 percent sRGB support. Its image looked bright, with vibrant color and good contrast. The biggest issue I have with the display doesn't concern its performance but its size. Quite simply, it feels too cramped for serious design work. It has a 16:9 aspect ratio, which limits the amount of vertical space it affords (go.pcworld.com/vtsp) compared with a 16:10 display. The HP Envy 14 features a roomier 14-inch, 16:10 display that's a better fit for creative work. Even a 13.3-inch MacBook Pro feels more spacious than the 14-inch Swift X because Apple's laptop displays feature a 16:10 aspect ratio.

Above the display is a standard 720p webcam. You won't wow your fellow Zoom conference attendees with the noisy image and reddish skin tones it produces. The webcam also lacks a physical privacy shutter.

The speakers, too, failed to impress. They didn't reach a loud level at max volume and produced predictably tinny sound. They also fire downward, which doesn't help.

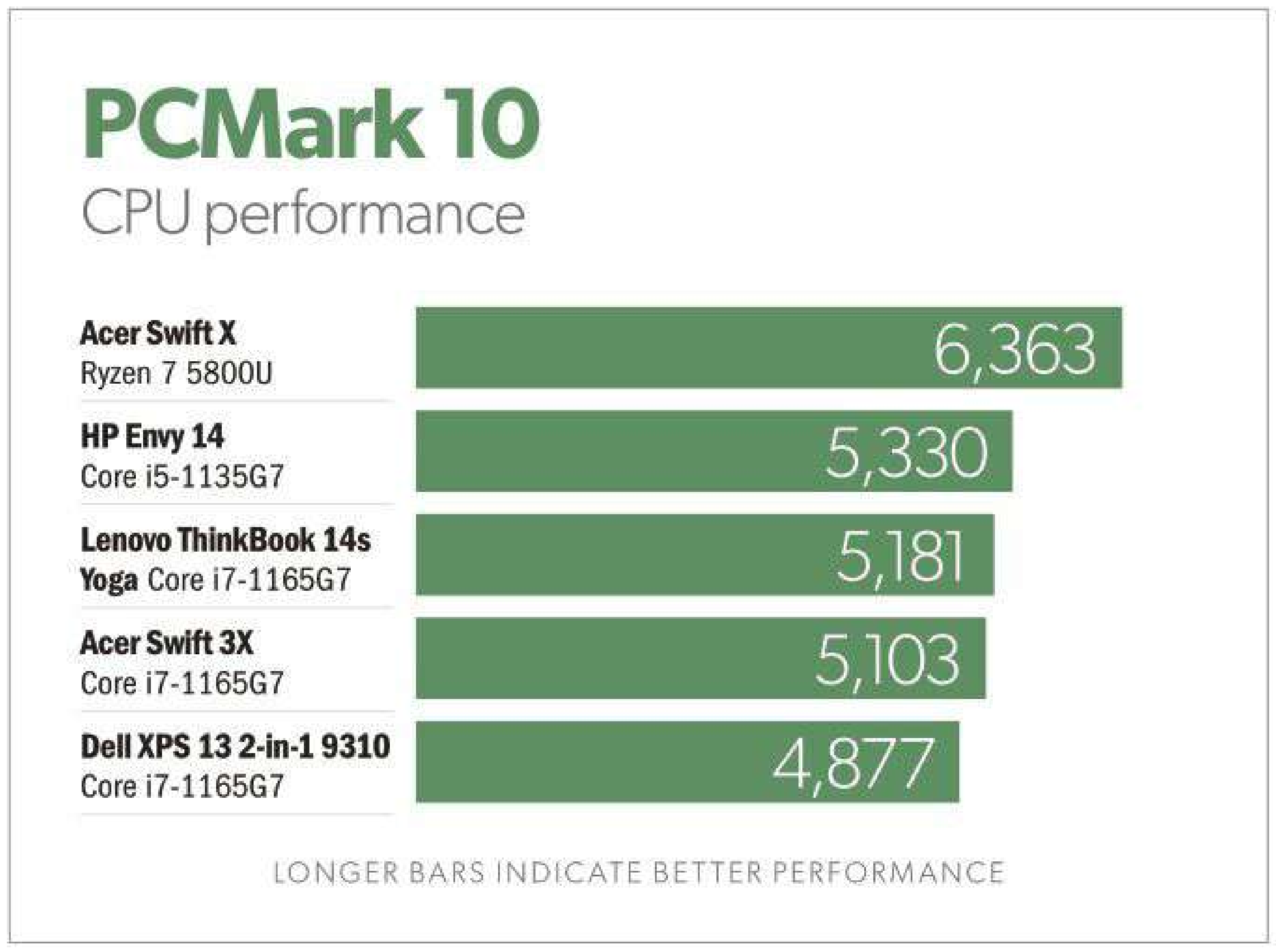


The Swift X's port selection covers the basics with both USB Type-A and Type-C ports, although I'd like a pair of USB-C ports and one USB-A port instead of the flipside of that. The USB-C port offers 10Gbps data transfers, DisplayPort support, and power delivery. Creative pros whose work requires the use of media cards will bemoan the lack of an SD card slot. The laptop supports the latest wireless networking standards—WiFi 6 and Bluetooth 5.2—but omits an Ethernet port. You'll also find an HDMI connection.

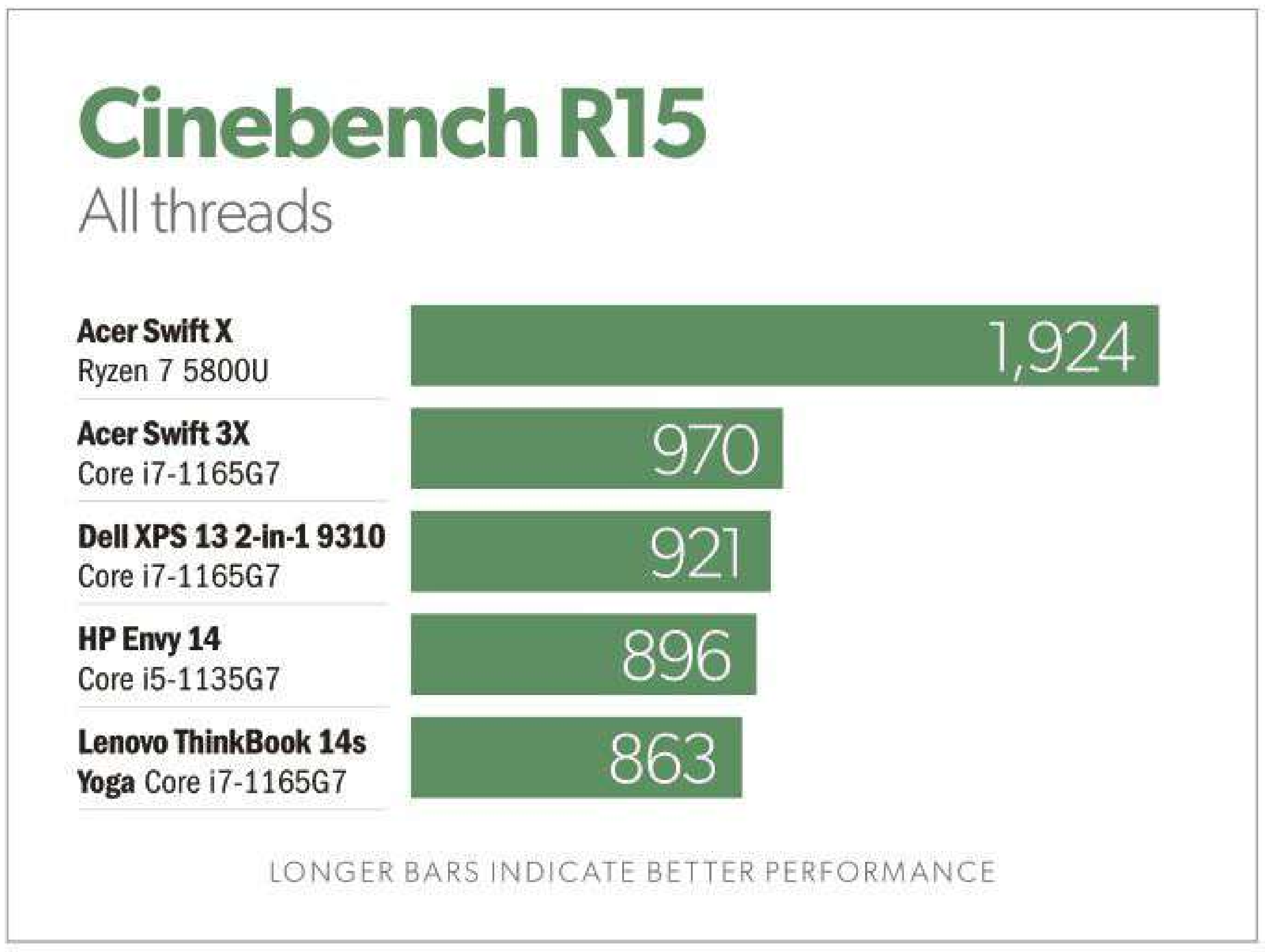
PERFORMANCE

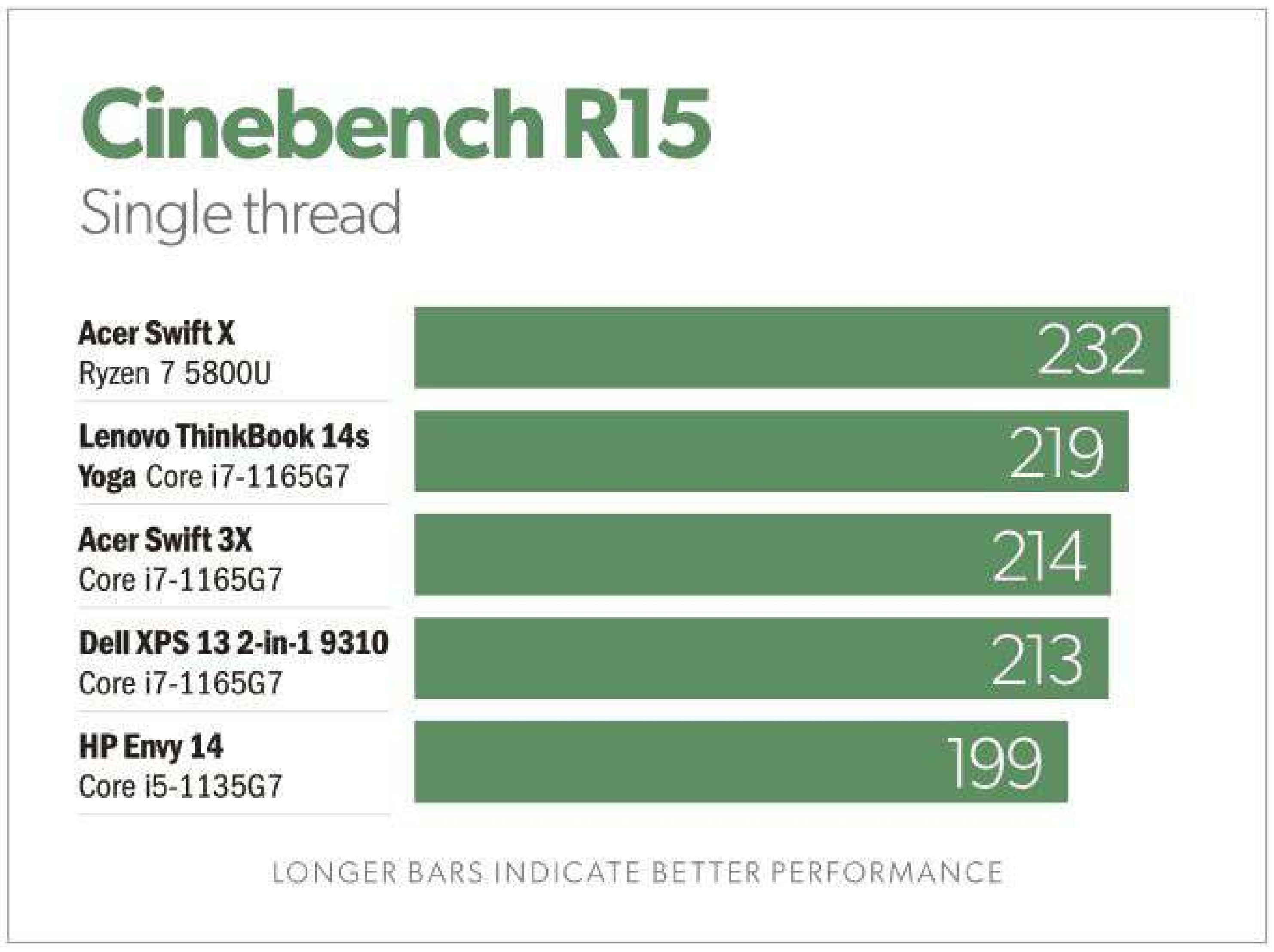
The Swift X shined in labs testing, easily outpacing competing ultraportables. The closest laptop we've reviewed recently to the Swift X is the HP Envy 14 (go.pcworld.com/env4), a 14-inch laptop built for content creation that features an 11th-gen Core i5 CPU and GeForce GTX 1650 Ti Max-Q graphics. We also compared the Swift X to Acer's Swift 3X (go.pcworld.com/st3x), which is based on an 11th-gen Core i7 CPU and Intel's discrete Iris Xe Max graphics. Rounding out the charts is the Lenovo ThinkBook 14s Yoga (go.pcworld.com/14sy) and Dell XPS 13 9310 (go.pcworld.com/9310), a pair of 2-in-1 convertibles with an 11th-gen Core i7 CPU and integrated Intel Iris Xe graphics.

Our first benchmark is PCMark 10, which measures performance on everyday computing work including office productivity tasks, web browsing, and video chats. The Swift X was the clear winner, beating the next closest system by more than 1,000 points.



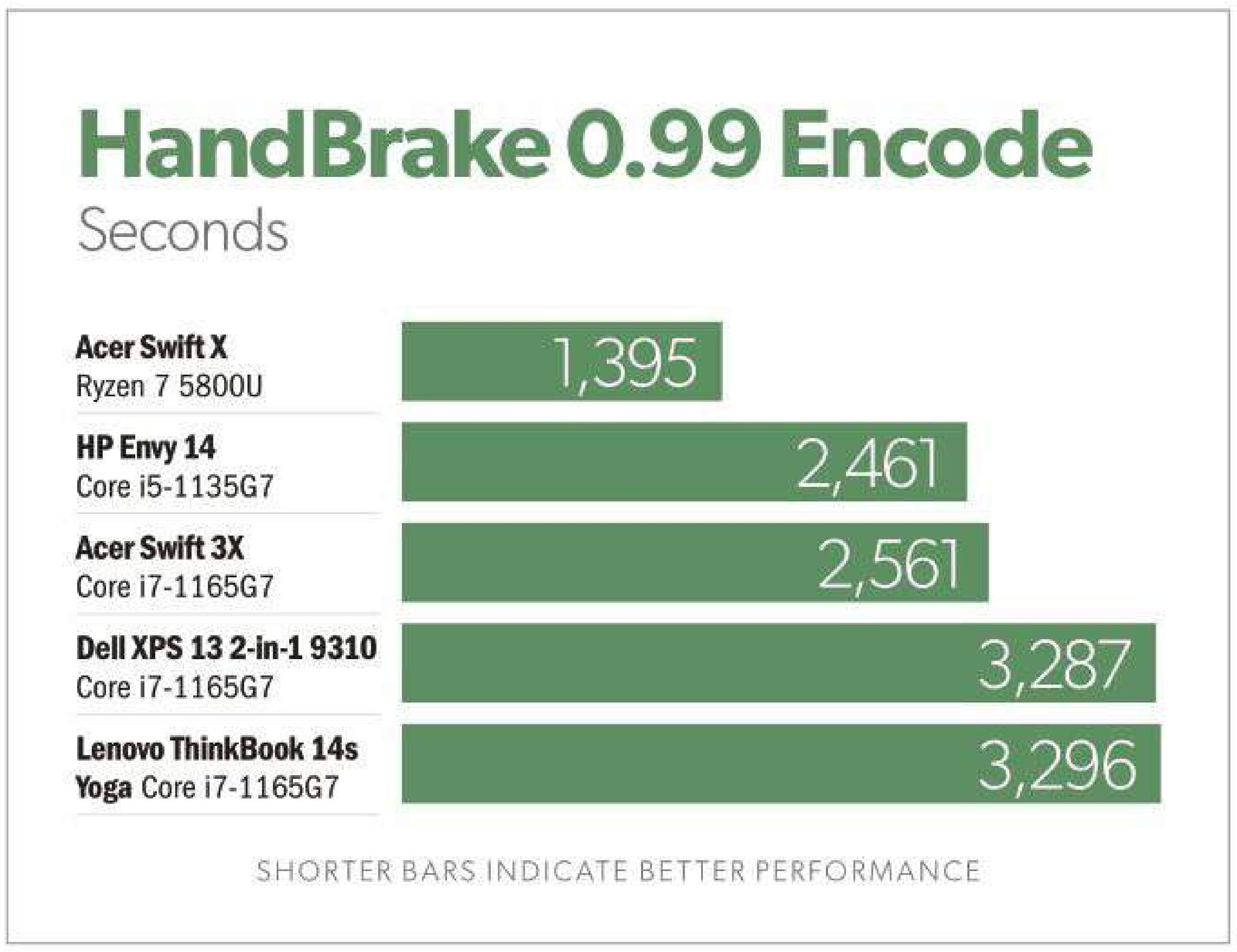
Next up is Cinebench, a sort of CPU sprint that stresses the CPU rather than the GPU and makes use of all processing cores. The Swift X dominated here on the multithreaded test for the simple fact that its Ryzen CPU has twice the physical cores and processing threads than the chips in the other systems. The Ryzen 7 5800U is a threaded, eight-core processor, and the Intel Core i5-1135G7 and Core i7-1165G7 are threaded, four-core chips.




Cinebench R15

Single thread

LONGER BARS INDICATE BETTER PERFORMANCE


HandBrake 0.99 Encode

Seconds

SHORTER BARS INDICATE BETTER PERFORMANCE

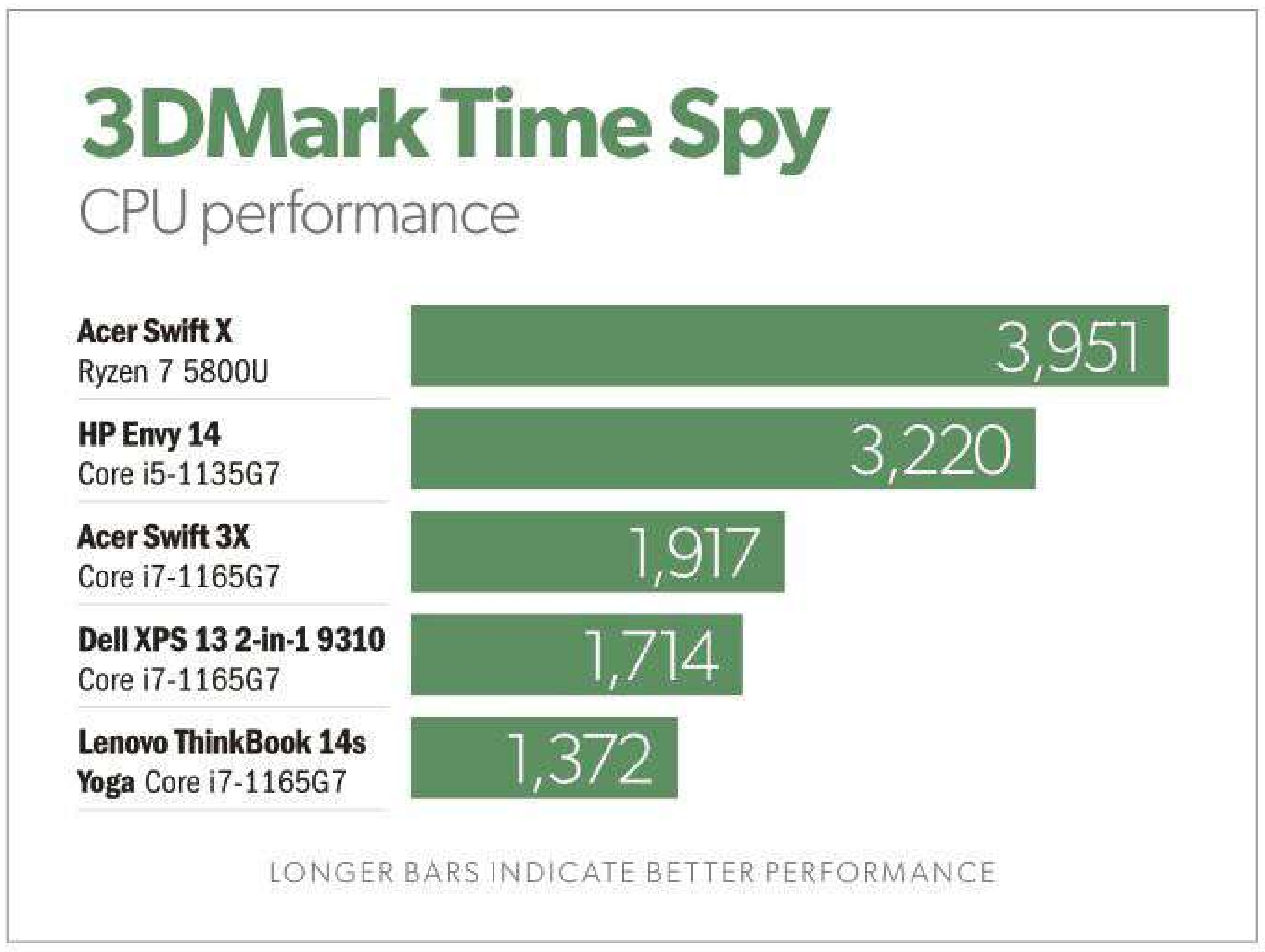
Twice the cores and threads leads to the Swift X posting a Cinebench score that's nearly double the score of the Swift 3X and more than double that of the others.

The Swift X also performed well on the single-thread test of Cinebench, although not to the degree of the multithreaded test.

We use the HandBrake utility to convert a 30GB movie to Android table format, an intensive task that taxes the CPU and all its cores. Again, the Swift X blasted the competition. It completed the test in nearly half the time of the HP Envy 14, its closest competitor.

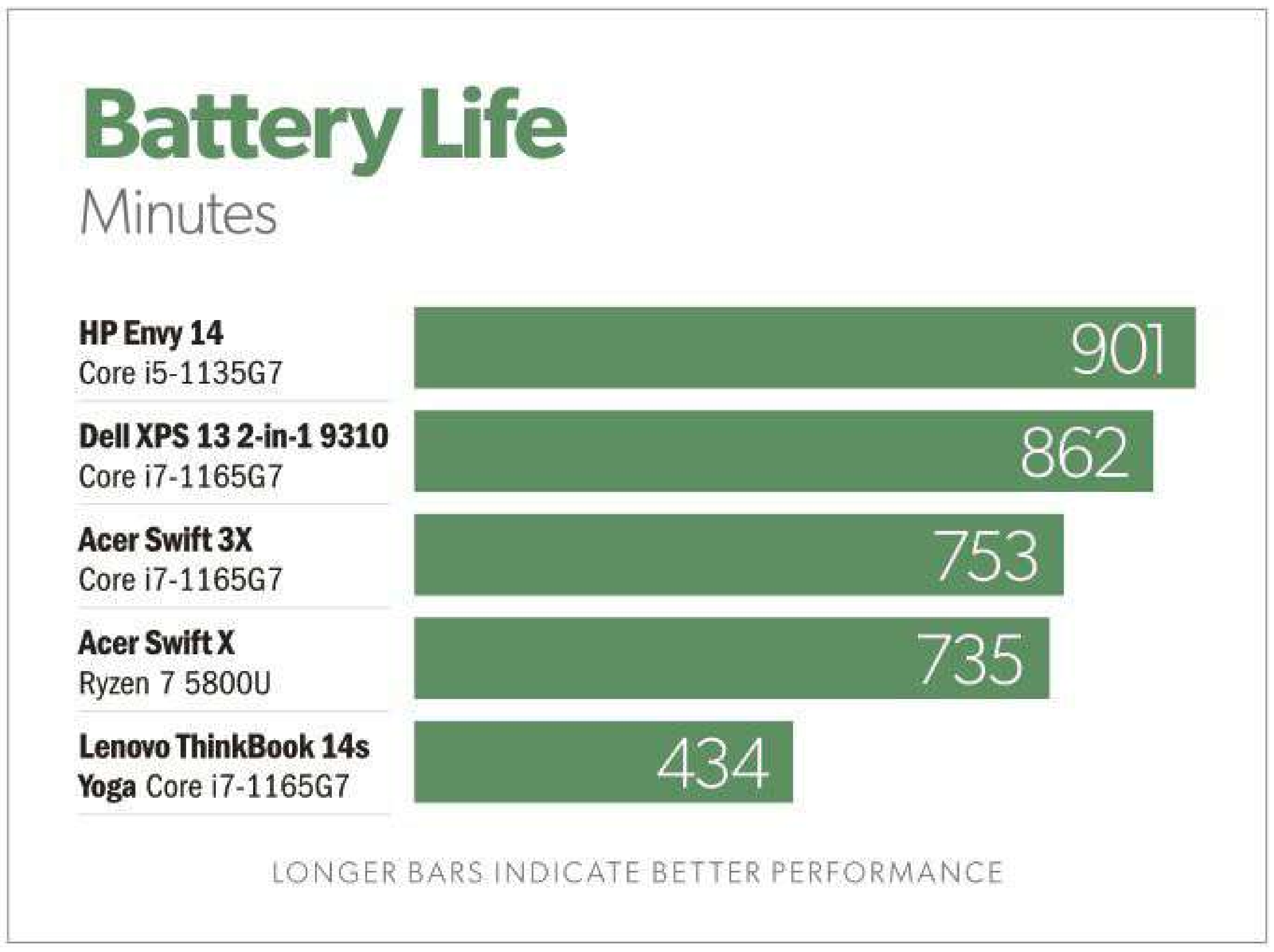
The Swift X and its RTX 3050 Ti graphics produced more than double the output of the laptops with integrated Intel graphics on our 3DMark benchmark. The HP Envy 14 and its GTX 1650 Ti Max-Q performed admirably but its score was still a considerable distance behind that of the Swift X. The Swift X has the graphics oomph to handle content-creation chores.

Because the Swift X features discrete graphics from Nvidia's latest lineup of GPUs, we ran a few games on the system. On *Shadow of the Tomb Raider* at 1920x1080, it averaged 48 frames per second at the Highest preset. On the more demanding *Metro Exodus* at 1920x1080 at the benchmark's Extreme preset, the Swift X averaged only 16 fps but improved to 52 fps at the Normal preset. Keep the quality settings in check and you'll achieve playable frame rates at 1080p. With its compact design and graphics muscle, the Swift X could make a good fit for people who want


3DMark Time Spy

CPU performance

LONGER BARS INDICATE BETTER PERFORMANCE


Battery Life

Minutes

LONGER BARS INDICATE BETTER PERFORMANCE

an easily portable laptop to take to class or around the office each day that also has some gaming chops when you get back to your home or dorm—once your homework is done, of course.

We test laptop battery life by looping a 4K video using the stock Windows Movies & TV app, with screen brightness set to about 250 nits, the volume dialed to 50 percent, and headphones plugged in. The Swift X doesn't offer the longest battery life among ultraportables, but it lasted for more than 12 hours on our battery-drain test, an impressive result given its high-powered parts.

BOTTOM LINE

There's no question that the Acer Swift X provides enough CPU and GPU performance for on-the-go content creators. With an octo-core Ryzen 7 5800U, the Swift X offers blazing application performance and strong multimedia performance. Add in the RTX 3050 Ti graphics, and you get a considerable boost in 3D graphics and gaming capability from the ordinary ultraportable with an integrated GPU. It's rare to find a laptop this compact with this much performance. And you aren't forced to sacrifice all that much in battery life for this power.

What prevents us from giving it a stronger recommendation for creative types is the Swift X's cramped display. In particular, the 16:9 aspect ratio makes the screen feel restrictive. I'm not saying you need a 15.6-inch or larger laptop to run Photoshop and other media-creation and -editing apps, but I would argue you need at least a 14-inch display with a 16:10 ratio. The 14-inch, 16:9 display isn't a barrier, however, for gamers. It's a better fit as a laptop for students or office workers: light enough for carrying around each day and powerful enough for playing games each night.

Acer Swift X

★★★★☆

PROS

- Stellar ultraportable performance.
- Sneaky gaming laptop with RTX 3050 Ti graphics.
- Impressive battery life considering high-end parts.

CONS

- Display feels cramped for creative work.
- Fan gets loud during heavy workloads.
- Poorly placed Page-up and -down buttons.

BOTTOM LINE

Billed as an ultraportable for creative pros, the powerful Acer Swift X is a better fit for students looking for a highly portable laptop with some gaming chops.

$1,069

GameSir GK300: Wireless mechanical keyboard goodness, just not for gaming

A removable wrist rest, backlighting, and a full-size layout help this wireless mechanical keyboard stand out. **BY MICHAEL CRIDER**

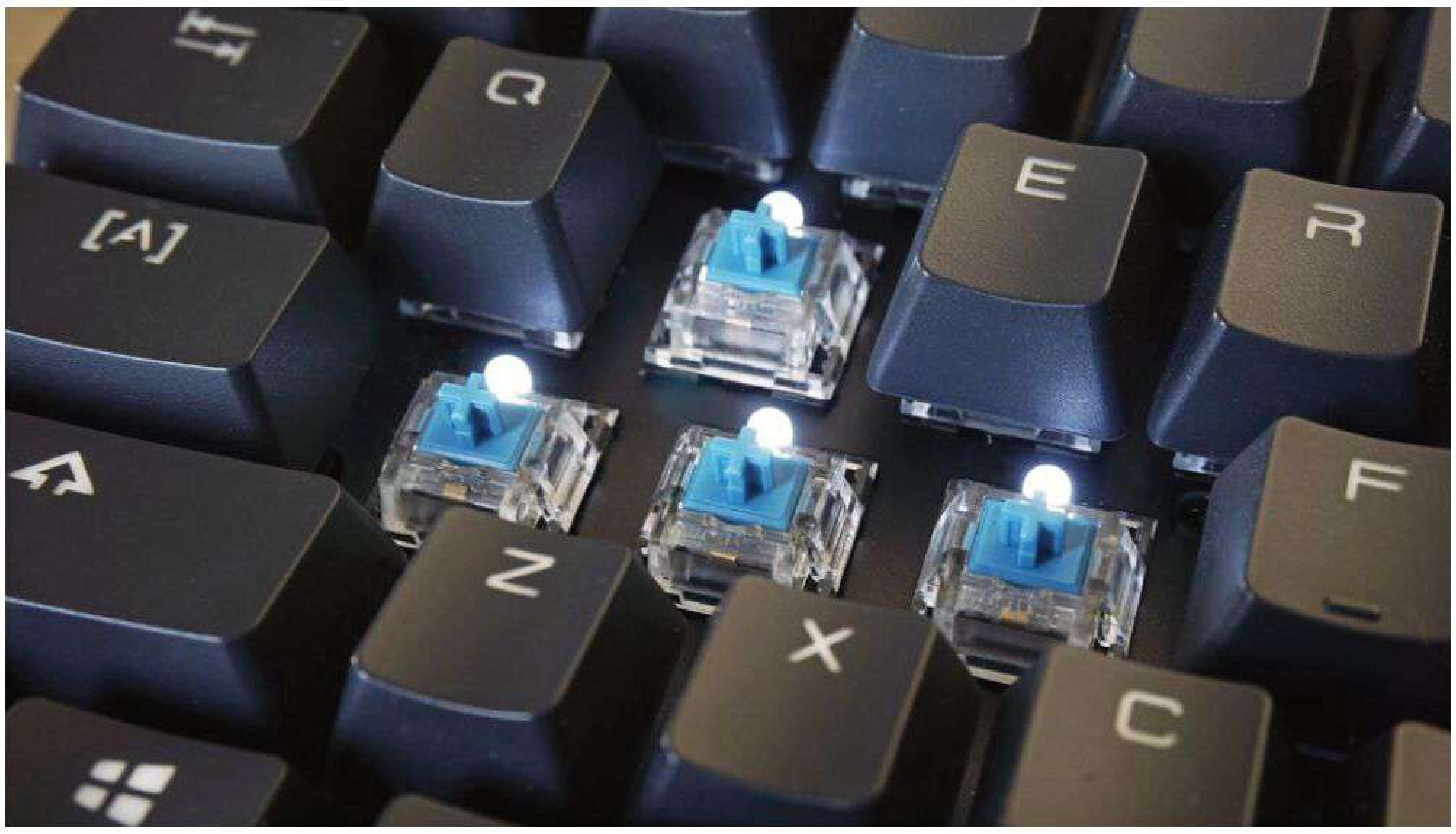
Say you want a keyboard that ticks every box: You want a full-size beast, eye-catching backlit keys, an included wrist rest, multiple wireless options, and trendy mechanical keys. From big-name suppliers like Logitech, you're looking at spending $150 to $200. Budget manufacturer GameSir will give you all of that for an impressively frugal 80 bucks.

Is the GK300 as good as keyboards twice its price? No. Frankly, it's not even particularly impressive for gaming, thanks to its use of clicky imitation Cherry Blue switches. But it's a fantastic value if you want a full-size wireless mechanical board with extra bells and whistles.

DESIGN AND FEATURES

With a standard 108-key layout, the GK300 should be familiar to anyone who demands a

IMAGE: GAMESIR



The key stems on the GK300 accommodate any Cherry-style keycaps, though the switches themselves are inferior Cherry knockoffs.

10-key number entry. And as a bonus, its standard stems and keycaps mean that it's compatible with almost all Cherry-style mechanical keycap sets. The switches themselves are decidedly *not* Cherry: They're low-price, imitation Blues from TTC. And there's enough rattle and wobble in the key action to make custom keyboard snobs turn up their noses. But if you're looking for something with a long travel action and enough clickity-clack to piss off all your office mates, they work.

A detachable wrist rest is an unexpected extra from a keyboard at this price.

The GK300 comes with a surprising array of extras that you wouldn't expect from a wireless mechanical board at this price. In addition to the included detachable wrist rest (very comfy, if unfortunately limited to one angle), there's white backlighting with a variety of effects and animations, a tough aluminum plate on the top of the body, and two types of wireless connectivity options.

CONNECTIVITY

You can choose between 2.4GHz RF to the dongle or Bluetooth via the power switch above the num pad. (Note that the included USB cable is for charging only—the battery lasts about a week with full-brightness lights, or months and months without them.) This effectively means the keyboard can switch between two machines, PCs or mobile devices, on the fly. You'll have to do without custom key programming, but on a board this big, I doubt anyone will miss it.

ESC
F1
1!
2@
3#
Q
W
A
[A]

A MicroUSB cable is included for charging the GK300.

The keyboard's recharging port is an awkward and outdated MicroUSB on the left side. This is going to be particularly annoying if you use your mouse with your left hand. What's even more annoying is that the 2.4GHz RF connection is a bit weak: With my Razer mouse (and its admittedly intense wireless connection) on the right, I noticed the keyboard lagging and missing keys. Rearranging the location of the dongle fixed it, but it's something to be aware of: You might want to switch to Bluetooth if your office is bathed in 2.4GHz gadgets.

BOTTOM LINE

While this budget board won't blow you away if you're used to high-end mechanicals, and its loud, clicky switches and so-so wireless connection aren't suited for gaming, that doesn't mean the GK300 doesn't have merits. Give it a shot if you're looking to save a bundle on a big, full-featured keyboard for standard duties.

GameSir GK300

★★★½☆

PROS

- Included wrist rest.
- Backlighting.
- Dual 2.4GHz and Bluetooth wireless.

CONS

- Limited to Blue switches.
- Iffy wireless dongle performance.
- Awkward charging port.

BOTTOM LINE

The GameSir GK300 isn't great for gaming, but it's a surprisingly capable option for general use if you want tons of features in a big wireless mechanical keyboard at less than half the price of most others.

$80

Gateway 15.6-inch Ultra Slim Notebook: Big screen on a budget

Getting a 15.6-inch display at this price is nice, but there are trade-offs. **BY JARED NEWMAN**

Gateway
Gateway
Tuned by THX

The Gateway 15.6-inch Ultra Slim Notebook is a classic budget PC. At $399 from Walmart (go.pcworld.com/w399), the price is hard to beat, especially considering its solid performance, decent storage space, and roomy screen size.

The trade-offs come from all the things that don't show up on a spec sheet. The display is harshly lit, with subpar viewing angles. The trackpad is abrasive. The plastic enclosure is creaky and wobbly, and battery life is woefully brief.

None of these compromises are new to the budget price range. Basic productivity is the realistic expectation here, and this laptop does have some strong points. If you're undeterred by the downsides, and you really

IMAGE: JARED NEWMAN

MicroSD slots aren't a given on laptops anymore, but Gateway's notebook has one.

can't spend more, Gateway's 15.6-inch Ultra Slim Notebook might fit your bill.

TECH SPECS

Our Gateway 15.6-inch Ultra Slim Notebook review unit includes the following features:

Display: 15.6-inch 1920x1080 IPS matte display

CPU: Intel Core i3-1115G4 processor

Memory: 8GB DDR4 RAM

Storage: 256GB SSD (W800SH)

Webcam: 720p

Biometrics: Fingerprint scanner

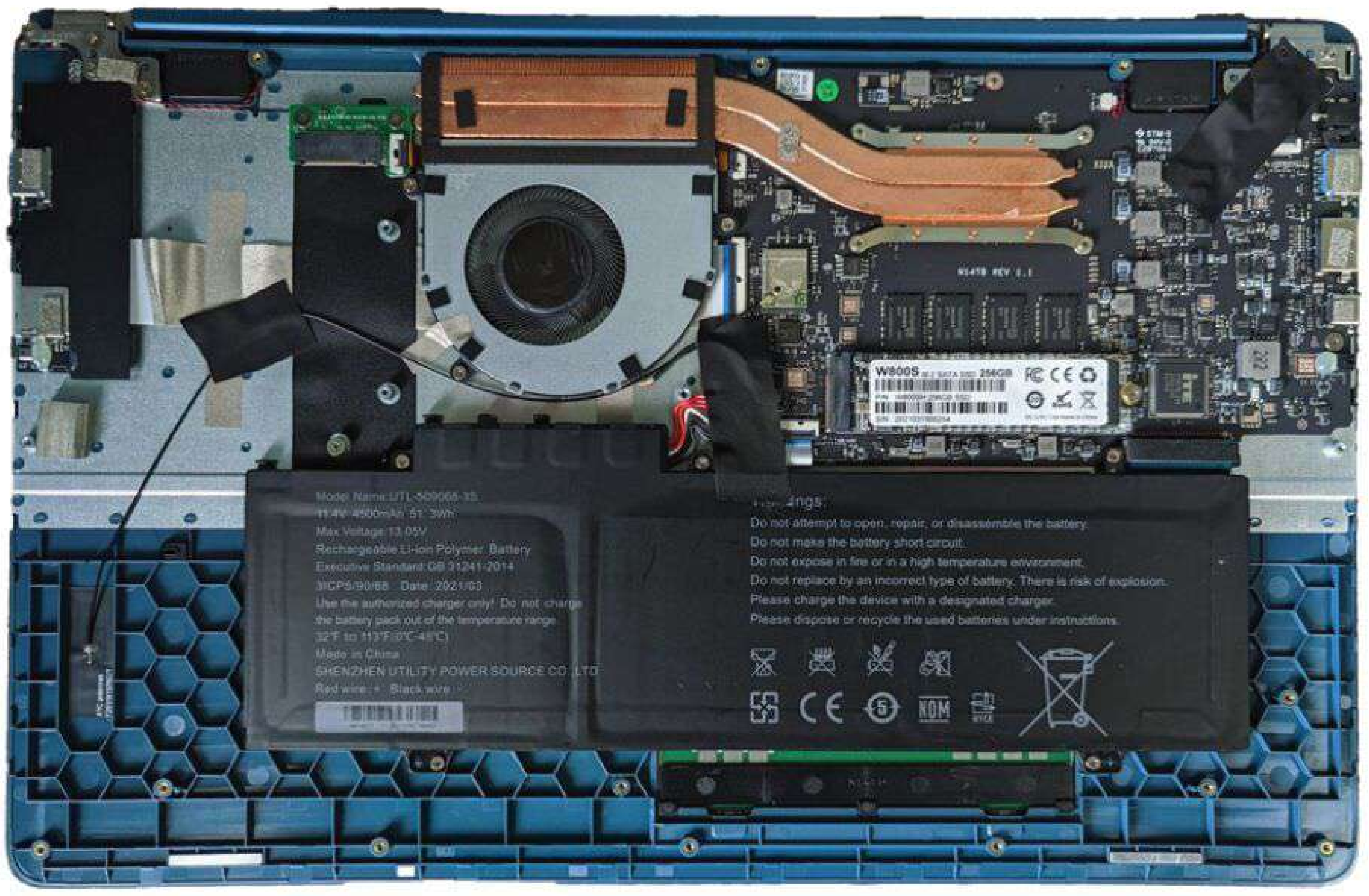
Left side: HDMI, USB-C, USB-A 3.0, barrel charger

Right side: USB-A 3.0, headphone jack, MicroSD slot (up to 512 GB)

Dimensions: 14.75 x 9.5 x 0.77 inches

Weight: 4.2 pounds (4.7 with power adapter)

Walmart, Acer's exclusive partner in resurrecting the Gateway brand (go.pcworld.com/gwbr), offers several other configurations. A version with AMD's Ryzen 5 3450U CPU sells for the same $399 (go.pcworld.com/g349), while a version with an Intel Core i5-1135G7 CPU, 512GB of storage, and 16GB of RAM sells for $579 (go.pcworld.com/g499). There's no 512GB storage option with the Core i3 processor, but the



Credit where it's due: This laptop's internals are easily accessible with a Phillips-head screwdriver and a fingernail.

MicroSD card slot—an increasingly rare feature on any laptop—provides an easy way to add more storage.

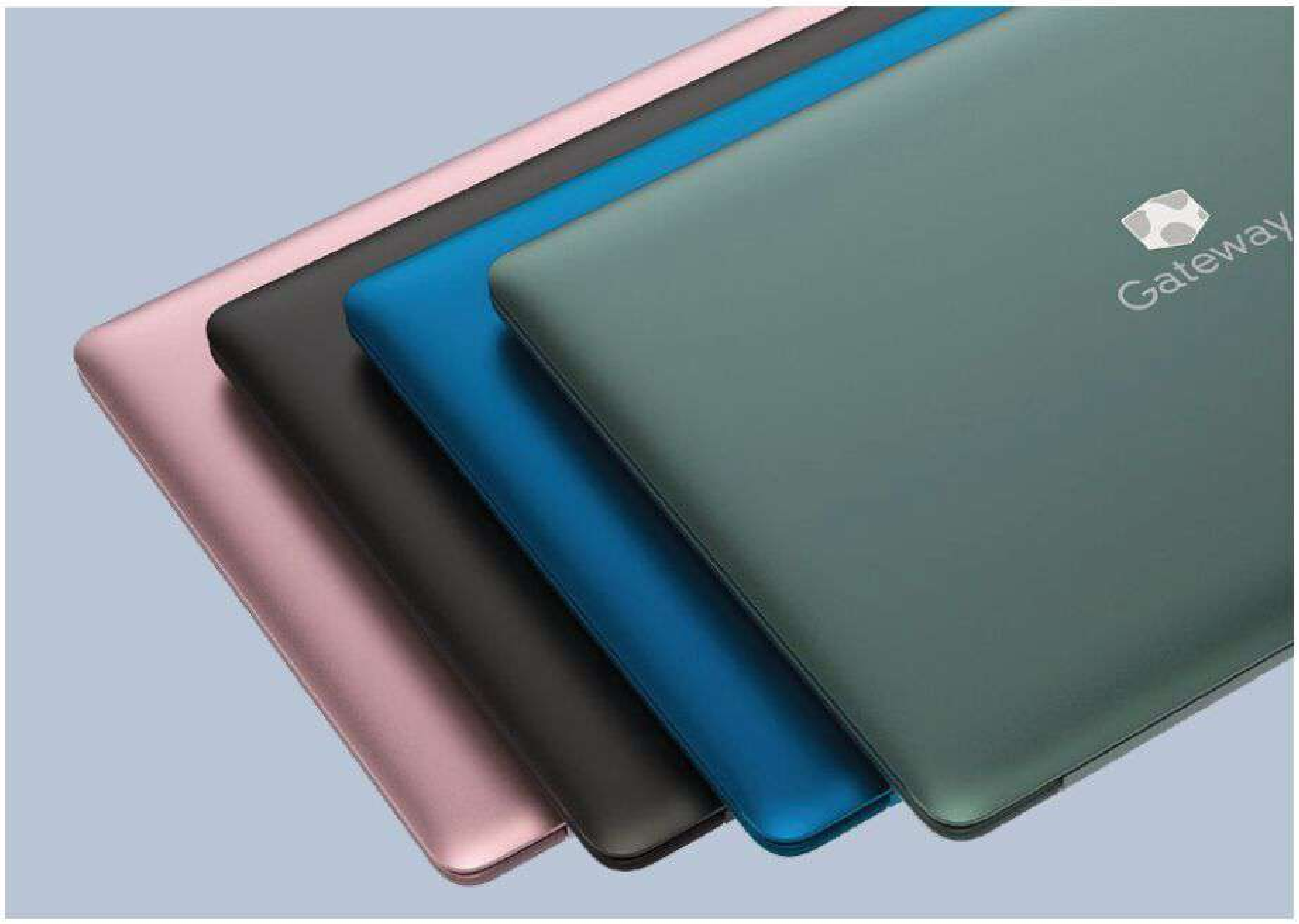
For those who like to tinker, this laptop is delightfully upgradable. A small hatch on the underside lets you throw in more memory. All you need is a Phillips-head screwdriver to pull off the entire rear panel, where you can access the battery and the M.2 SSD.

Sadly, the laptop's sole USB-C port doesn't support charging. That means you always have to use the included barrel charger, which charges slowly and comes with a space-hogging power adapter.

DESIGN AND DISPLAY

If not for the appealing, ocean-blue finish on this particular review unit, Gateway's 15.6-inch Ultra Slim Notebook would look much like any other low-cost, all-plastic laptop. It has thick bezels surrounding its matte display. The chassis will creak and crunch under your hands from the moment you pick it up.

Display quality is usually the first thing to go downhill in budget laptops. The 15.6-inch screen on this model is roomy but a little dim. It also emits an unnaturally bluish hue that puts a strain on the eyes. Although the display's IPS technology is supposed to enable a steady image from wide angles, you'll notice the screen darken and brighten as you tilt it. The screen's matte finish does have one advantage, though: It's easy to read outside, even on a sunny day.



The colorful body spruces up what's otherwise a pretty ordinary-looking laptop.

KEYBOARD AND TRACKPAD

Keyboard and trackpad quality are another area where the Gateway Ultra Slim laptop compromises to hit a lower price. While the keys themselves offer decent travel, they feel mushy and wiggly. The plastic enclosure contributes to a hollow feeling under your fingers.

The trackpad is worse: Its rough plastic finish makes your fingers stick and hinders fine-grained cursor movements. Build quality is an issue here as well, as pressing down firmly on the trackpad produced two audible clicks in a row. (Thankfully, only the first one registered as an actual mouse click.)

Gateway
Tuned by THX
Gateway

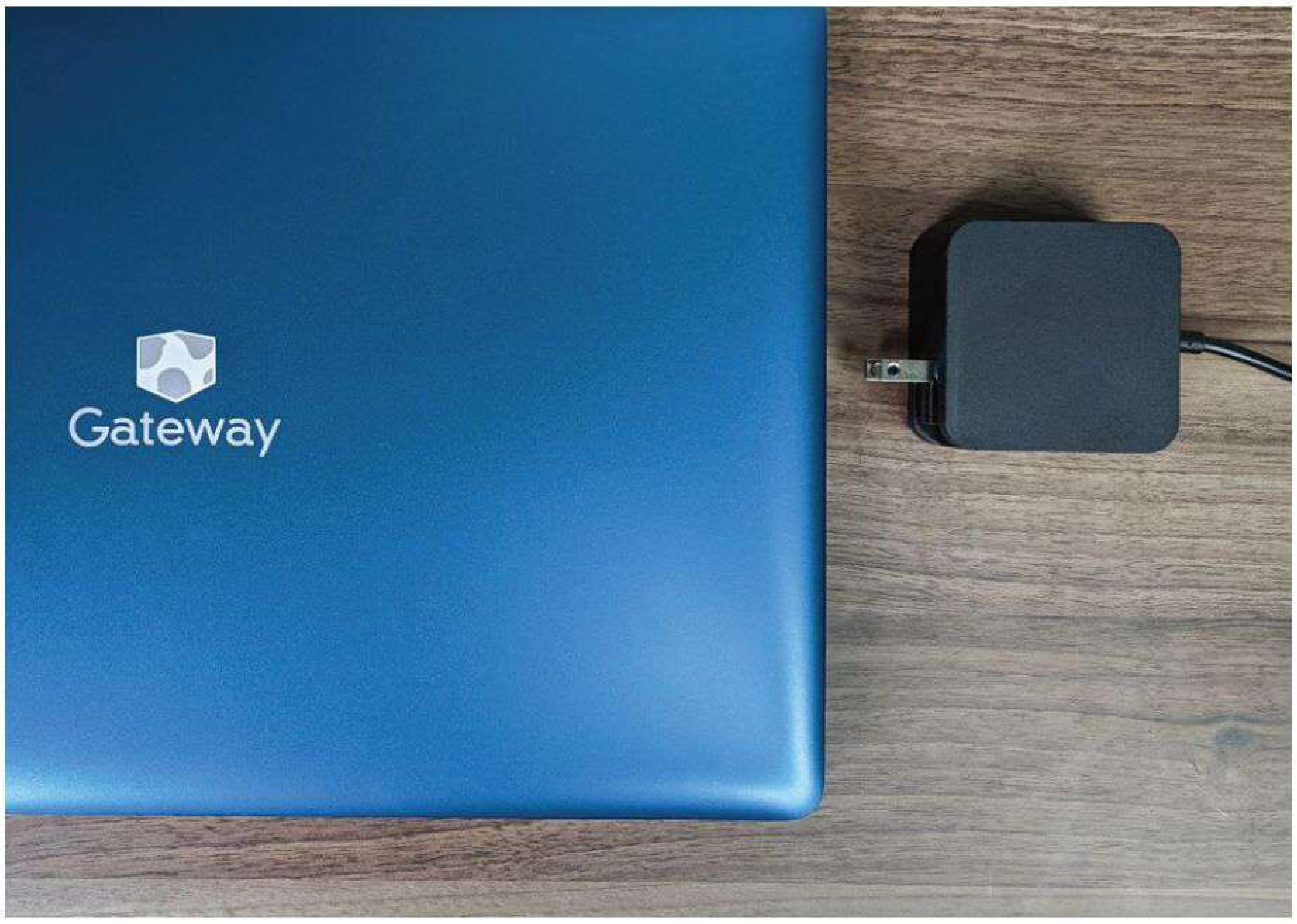
Consumer Reports pulled its recommendation of the Surface Laptop, even though the notebook wasn't covered in the survey.

WEBCAM, AUDIO, AND SECURITY

The Gateway 15.6-inch Ultra Slim Notebook's webcam offers the same 720p resolution as the vast majority of Windows laptops, most of which continue to treat camera quality as an afterthought. We wouldn't expect a camera on a $399 laptop to support Windows Hello face recognition, and this one doesn't. However, a privacy shutter or kill switch for the camera would have been nice.

The fingerprint reader is a nice security touch on a sub-$500 laptop, despite its odd position in the top-right corner of the trackpad.

Like a lot of other PC makers, Gateway follows the trend of partnering with a big audio brand to fine-tune its laptop speakers. In this case, the partner is THX, and as expected, this kind of aural window dressing can only do so much within a laptop's confined space. The upward-firing speakers are indeed well



To charge the Gateway laptop, you'll have to use its bulky power adapter and barrel charger.

balanced—you can listen to music or YouTube videos without feeling like you're trapped in a tin can. But they're on the quiet side, so you may strain to hear your video or conference call in noisy environments.

Microphone quality is sketchy. When I captured an audio sample, it made my voice sound somewhat nasal compared to what I've captured from other laptops. I could also detect its overly aggressive attempts at noise cancellation.

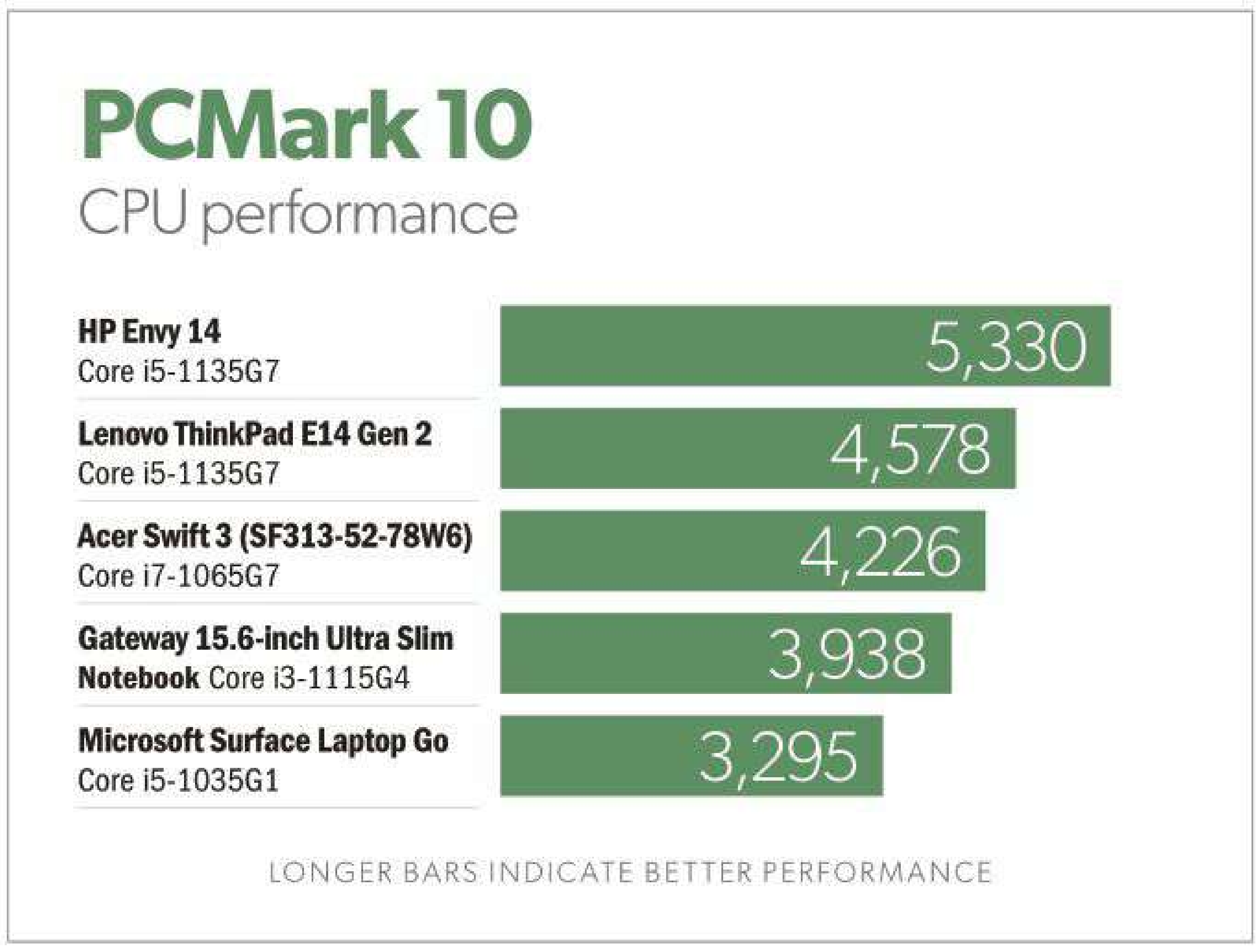
PERFORMANCE

We seldom get a low-end Intel Core i3 processor to test here at PCWorld. Most vendors want to show off the fastest versions of their computers, which means we typically end up with Core i7 or Core i5 configurations.

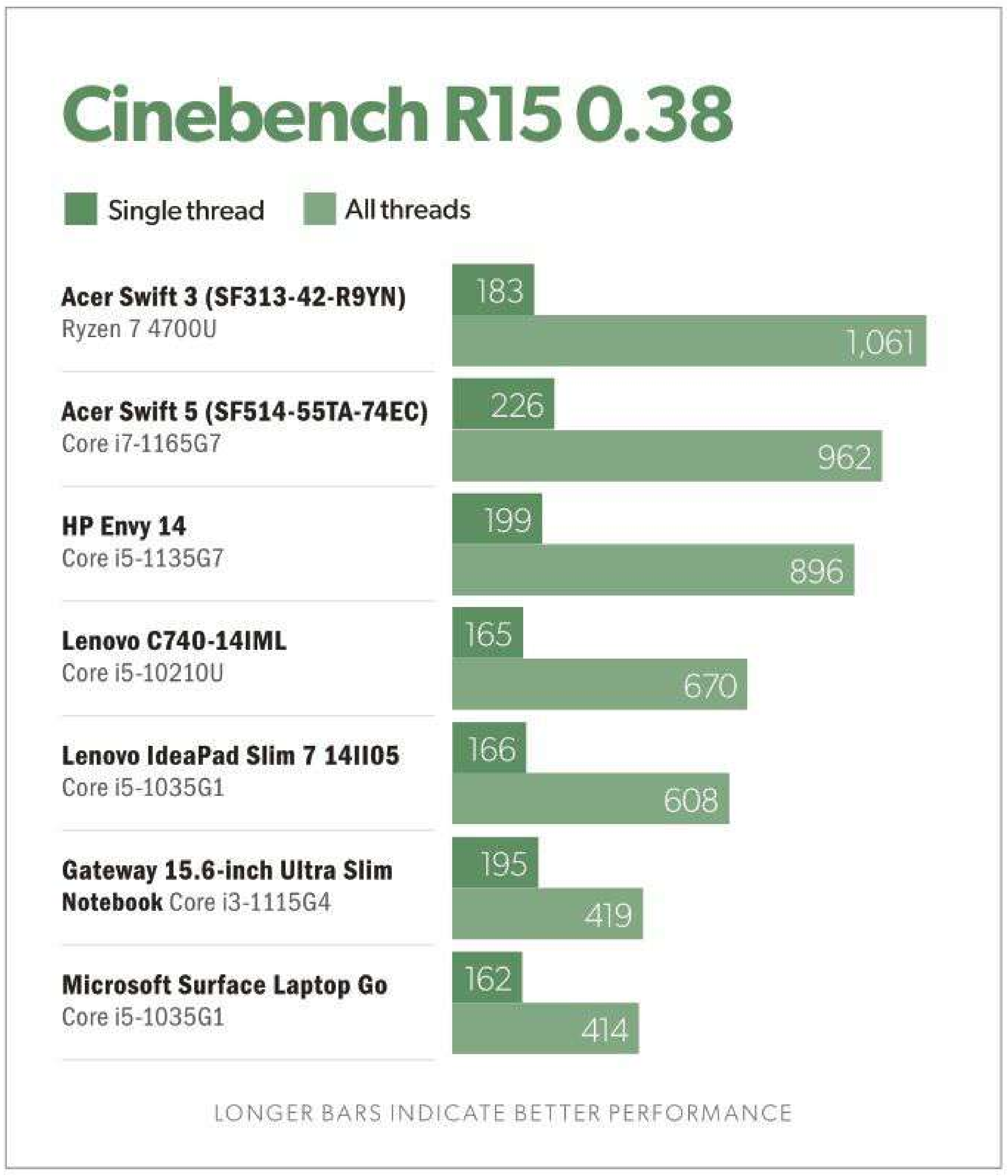
Using the Core i3-1115G4 processor in Gateway's laptop was clarifying. For basic document editing and web browsing, the Core i3 chip was perfectly zippy, proving that you probably don't need anything faster unless you're getting into media creation or gaming.

Unfortunately, that reality doesn't show up in benchmark tests, so keep that in mind as you peruse the charts below.

Starting with PCMark 10, which simulates a gamut of productivity tasks, the 15.6-inch Ultra Slim Notebook's 11th-generation Core i3 CPU did manage to outpace the 10th-gen Core i5 in Microsoft's Surface Go laptop. Not surprisingly, it fell well behind the performance of higher-end 11th-gen chips.



The Gateway 15.6-inch Ultra Slim Notebook performs just fine for productivity, even if its PCMark scores fall short compared to laptops with higher-end CPUs.

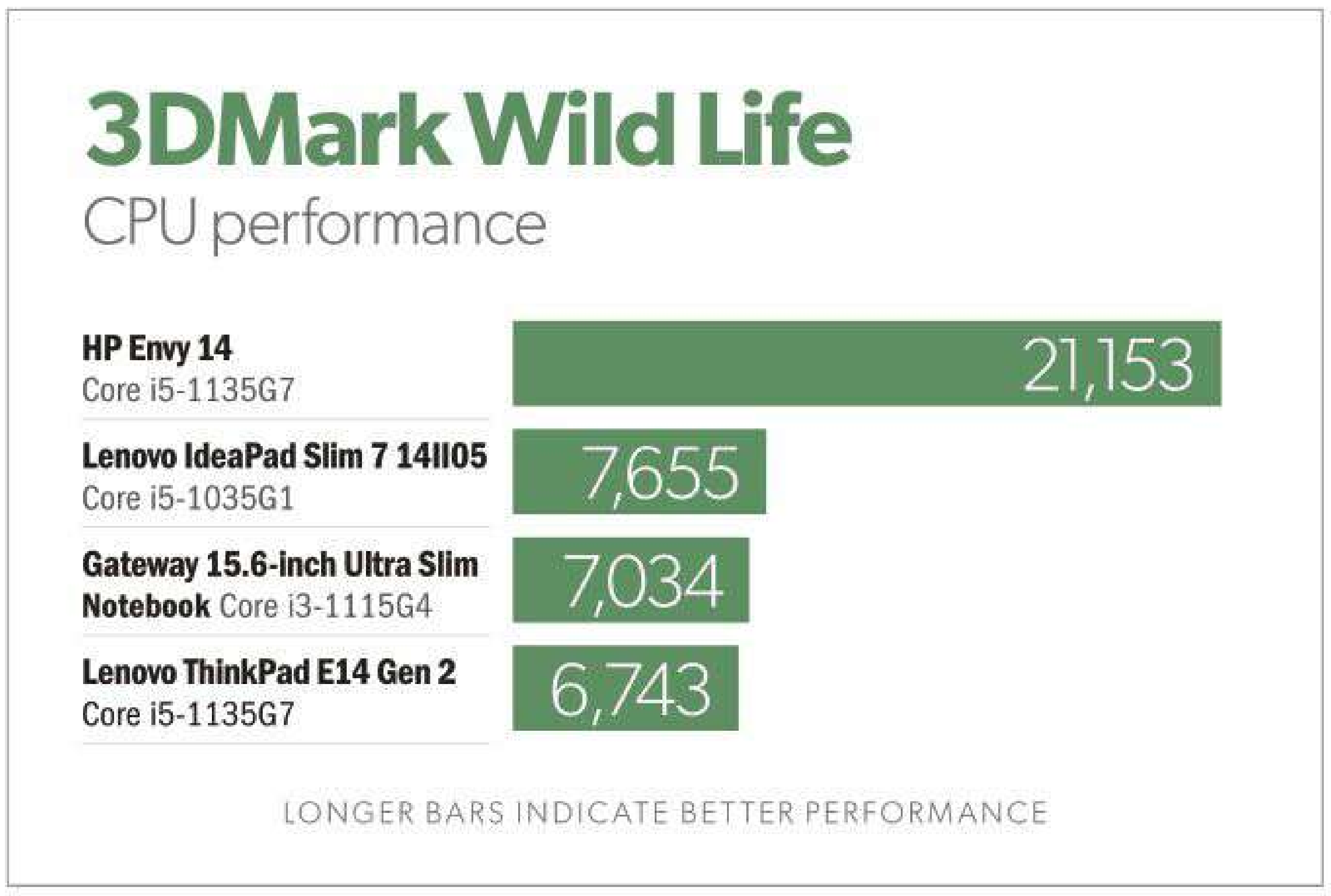


Single-threaded performance is what matters for document editing and web browsing, and Gateway's laptop does well with this task.

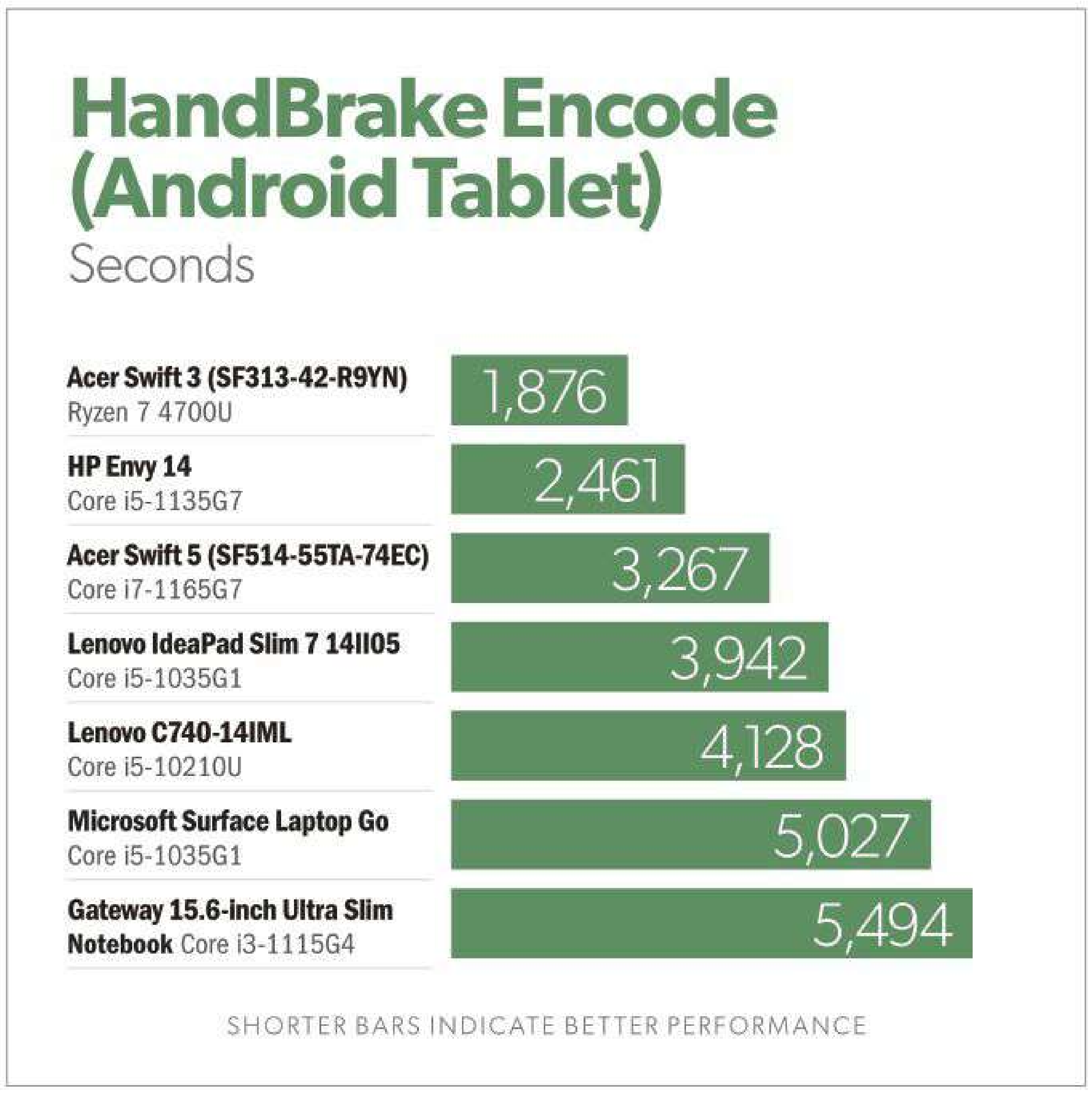
The Core i3-1115G4 is a dual-core processor, so as you might expect, multithreaded performance in Cinebench is lackluster. Still, single-threaded performance was impressive: Gateway's laptop beat out several 10th-gen Core i5 chips and held its own against the 11th-gen Core i5 in HP's Envy 14.

HandBrake is where that lack of multicore power really shows. This test involves encoding a large video file, as you might do if you were editing or converting personal videos. The task really benefits from availability of lots of computing cores. Gateway's laptop completed the job at a glacial pace of 1 hour and 32 minutes.

The other big downside to Core i3 processors is the lack of Iris Xe graphics for gaming. No one should expect a $399 laptop to be a gaming machine. In case you were wondering, though, here are our findings, via the 3DMark Wild Life benchmark (above) and some anecdotal gameplay: You might be able to eke out some lightweight indie games, but don't expect much more than that. Even the fairly lightweight first-person shooter *Amid Evil* was unplayable for me due to constant stuttering.



This isn't a gaming laptop, regardless of what the benchmark results say.



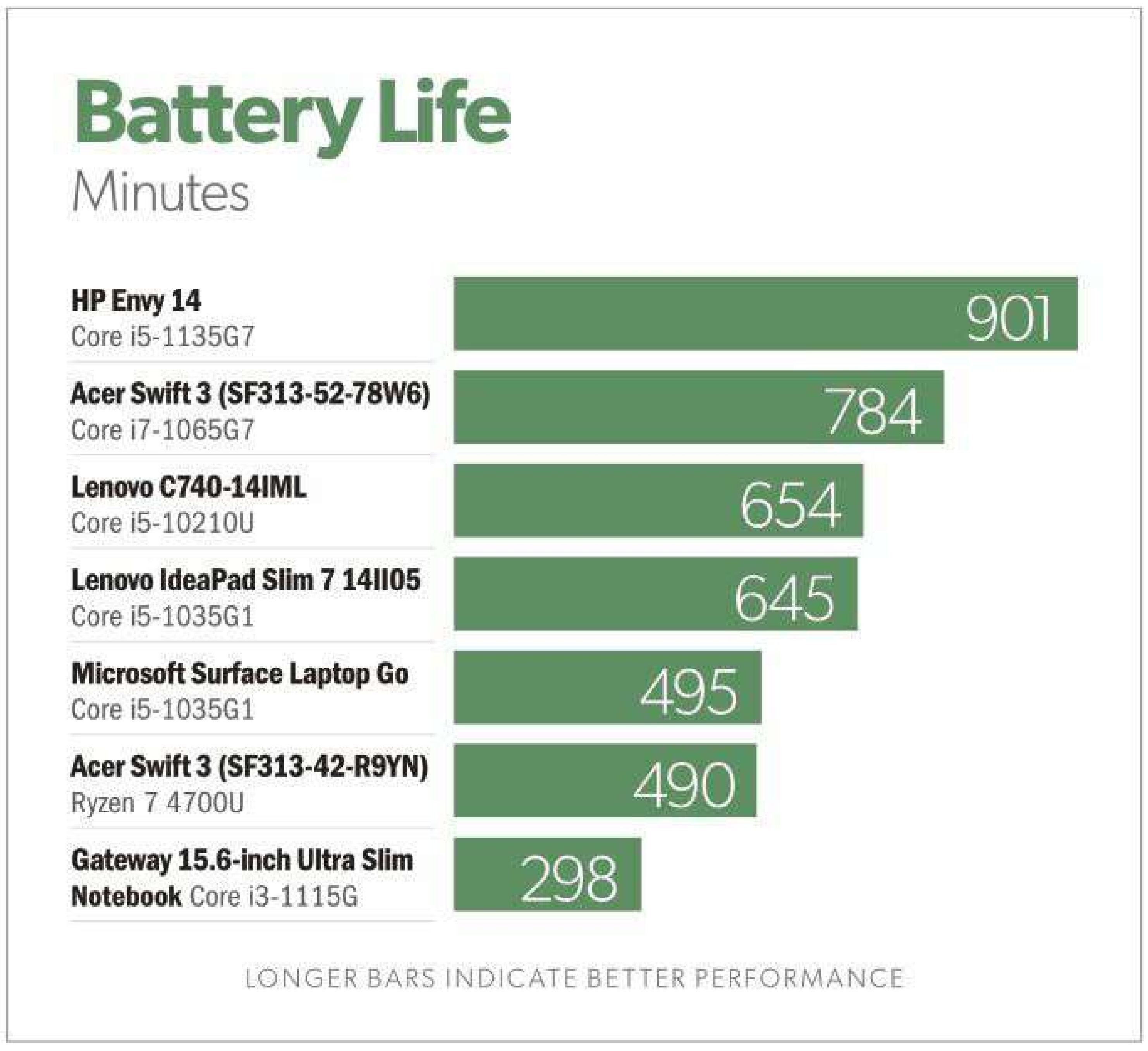
Don't expect the Core i3 processor to make quick work of video encoding.

BATTERY LIFE

Now for the potential deal-breaker: battery life. In our offline video rundown test, the laptop lasted just shy of 6 hours (5 hours and 58 minutes). That's more akin to what we see in power-hungry workhorse PCs than typical thin-and-light laptops. It squelches any hope you might have of being able to get in a full workday off the charger.

BOTTOM LINE

If $399 is all you can spend, the Gateway



Battery life is disappointingly weak.

15.6-inch Ultra Slim Notebook is a reasonable purchase. It offers basic productivity performance and a big display (though of middling quality).

If you're able to expand your budget, you might find a reasonably priced Windows PC without the Gateway's glaring downsides, especially by dipping back to previous model years. Lenovo's excellent C740 Yoga (go.pcworld.com/l740), for instance, still sells on Amazon for $640 (with a smaller-size SSD than what we tested; go.pcworld.com/am74).

For those who'll consider a Chromebook, the Acer Chromebook Spin 713 (go.pcworld.com/a713) regularly sells for less than its $629 asking price at Best Buy (go.pcworld.com/b699). HP's Envy x360 15 (go.pcworld.com/x315) is a classy convertible that sells for as little as $720 on HP.com (go.pcworld.com/h720). And while we wouldn't shout it from the rooftops, there's a solid case for using an entry-level iPad as a laptop alternative (go.pcworld.com/Ipal).

The Gateway 15.6-inch Ultra Slim Notebook's biggest saving grace may be its potential to work as a cheap desktop replacement. Real-world performance is pretty snappy; you can upgrade the memory if needed; and the HDMI port facilitates easy connections to external monitors. Using this laptop with an external display, keyboard, and mouse would sidestep many of its biggest shortcomings. You'd be hard-pressed to find a comparable desktop for $400.

Only when you take it on the road will you remember why it was so cheap in the first place.

Gateway 15.6-inch Ultra Slim Notebook

★★★☆☆

PROS

- Solid performance, storage, and screen size for the price.
- Easy access to the internal memory, storage, and battery.
- Fingerprint reader.

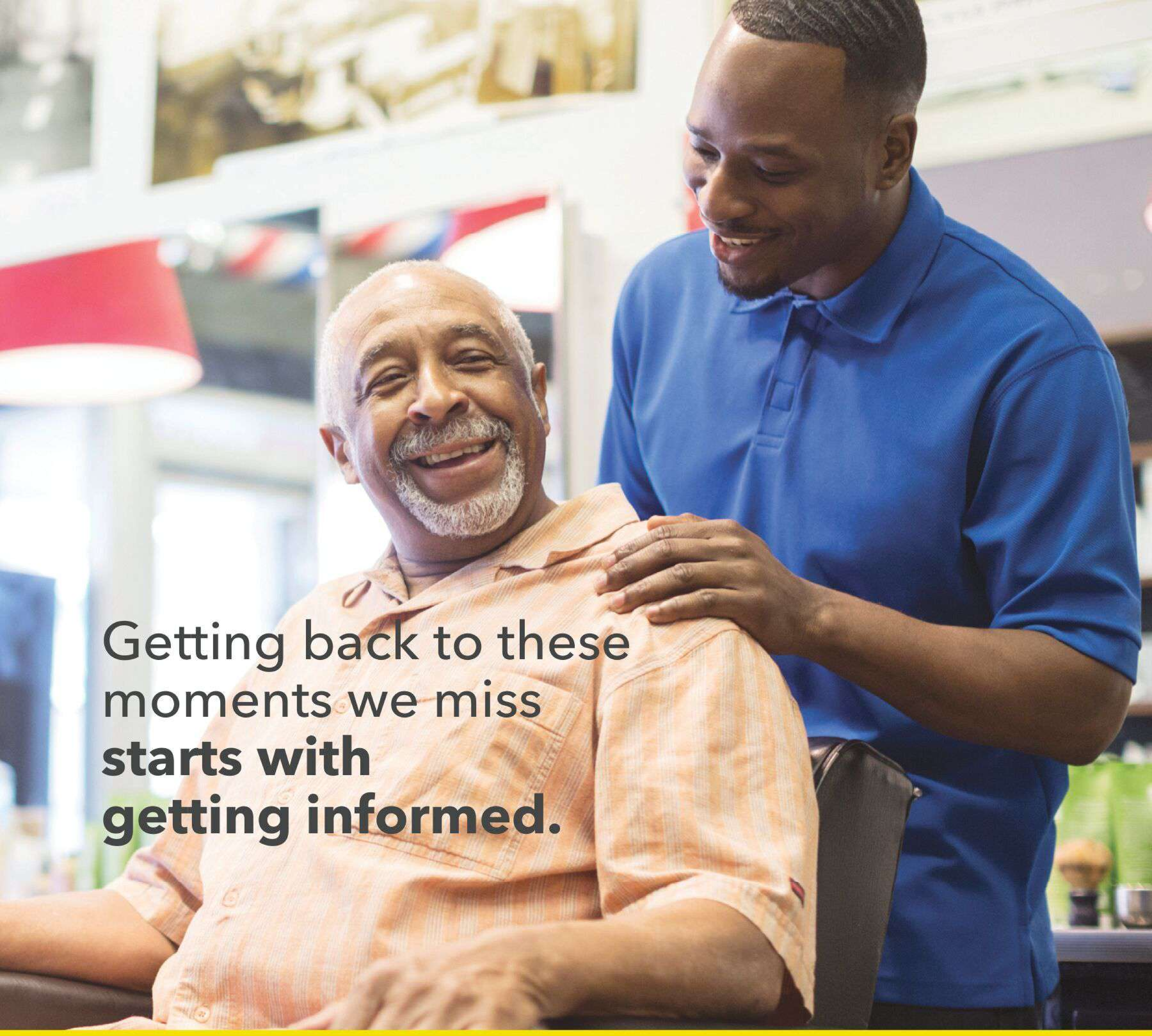
CONS

- Display has a harsh, bluish hue.
- Creaky plastic enclosure doesn't instill confidence.

BOTTOM LINE

Working under the Gateway brand, Acer makes lots of sacrifices to hit its $399 price point.

$399



Getting back to these moments we miss **starts with getting informed.**

IT'S UP TO YOU

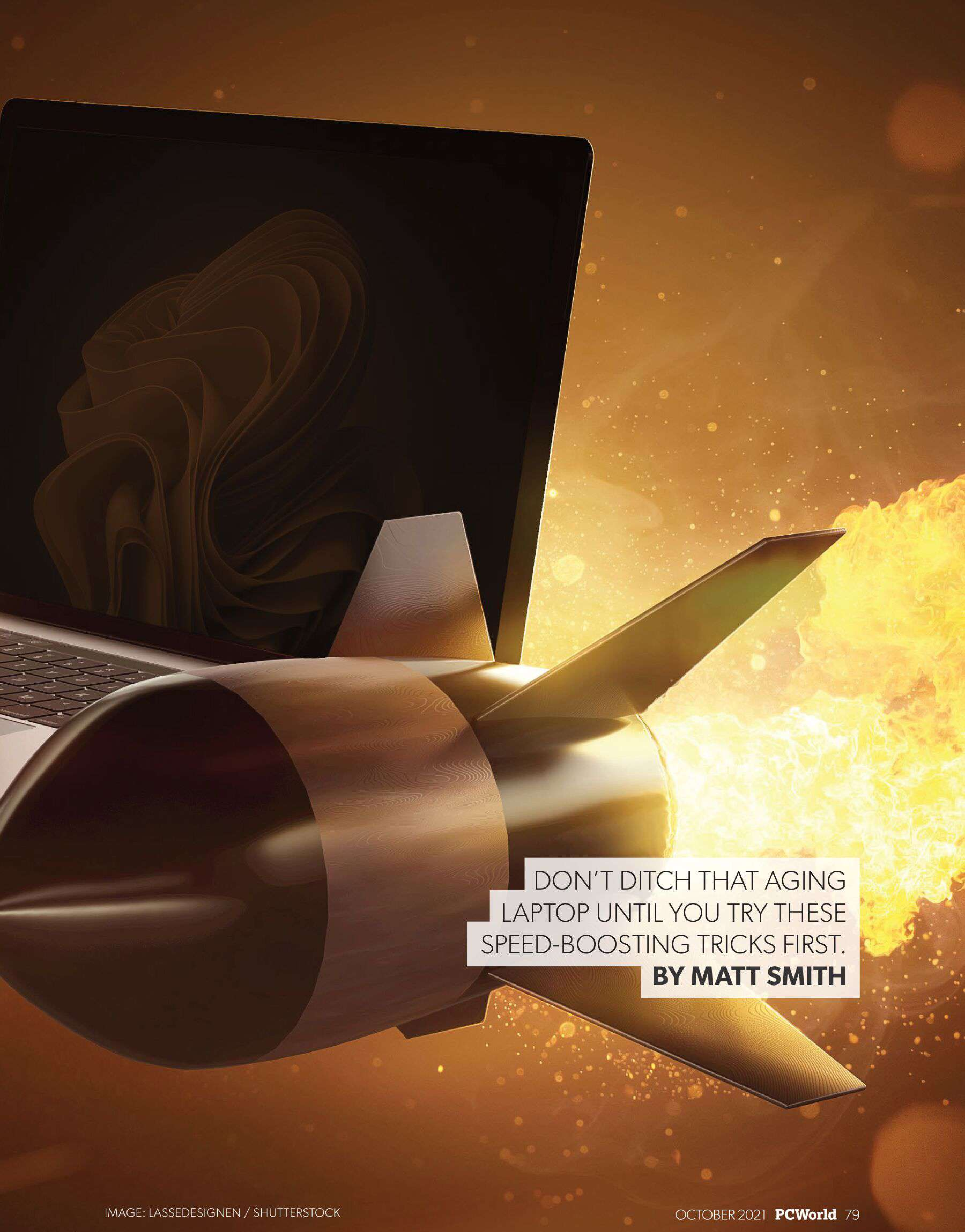
COVID-19 VACCINATION

ad COUNCIL

Get the latest information about COVID-19 vaccines at **GetVaccineAnswers.org**

DOES YOUR LAPTOP FEEL SLUGGISH?

TRY THESE **9 THINGS** BEFORE YOU GIVE UP



DON'T DITCH THAT AGING LAPTOP UNTIL YOU TRY THESE SPEED-BOOSTING TRICKS FIRST.

BY MATT SMITH

IMAGE: LASSEDESIGNEN / SHUTTERSTOCK

Does your laptop feel sluggish? Do you have to wait five minutes after rebooting the laptop before it responds? Does it struggle to switch between browser tabs even when you have less than half a dozen open?

A slow, frustrating laptop may have you shopping for a new model, but you should try these tips before you give up. Improving the performance of your aging laptop can extend its life by several years and keep it out of the landfill.

1. RESTART YOUR PC

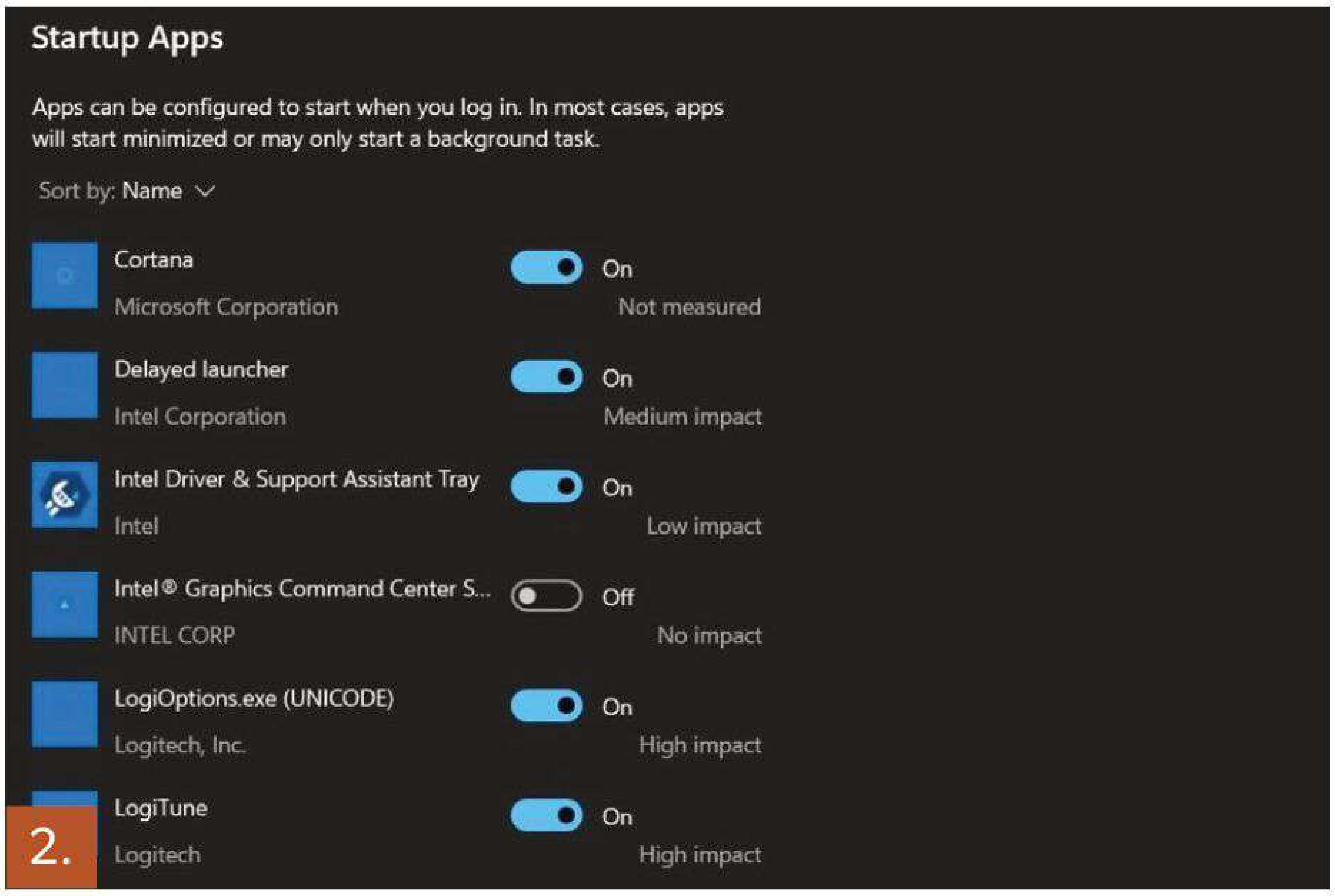
Have you tried turning it off and on again? It's a cliché for a reason. If anything, this trick is even more relevant today. A modern laptop is reliable and can be placed in an efficient sleep mode to save power. There's no reason to turn it off unless you're installing a Windows update or troubleshooting.

Give it a try. Shut down the laptop and turn it back on using the power button. It only takes a minute.

2. CLEAN STARTUP APPLICATIONS

A fresh start also lets you see what applications launch when your laptop boots into Windows. Many applications are designed to launch when Windows loads, and they tend to pile up over time. A large pile of startup apps can really bog down a laptop.

You can clean startup applications by opening Windows 10's Settings app. Select "Apps from" and then Startup. You will see a list of apps that launch at startup. Toggles next to each app let you enable or disable them. Windows even has an estimate of how much they impact boot times (though this estimate hasn't proven accurate in my personal experience).



2.

Startup Apps

Apps can be configured to start when you log in. In most cases, apps will start minimized or may only start a background task.

Sort by: Name

Cortana Microsoft Corporation	On	Not measured
Delayed launcher Intel Corporation	On	Medium impact
Intel Driver & Support Assistant Tray Intel	On	Low impact
Intel® Graphics Command Center S... INTEL CORP	Off	No impact
LogiOptions.exe (UNICODE) Logitech, Inc.	On	High impact
LogiTune Logitech	On	High impact

Most applications will appear in this list, but some may not. You can disable these apps the old-fashioned way with the Windows System Configuration application (go.pcworld.com/olfs).

3. CHECK YOUR INTERNET CONNECTION

Odds are most tasks you regularly perform on your laptop require an internet connection. Web browsing, Netflix streaming, and online gaming all require a healthy connection. A slow one can drag down performance.

You can check your internet connection with a speed test utility like speedtest.net (go.pcworld.com/spts). Run the test several times while recording your ping time, download, and upload speeds. You'll ideally want to see a ping time in the single digits with download and upload speeds above 10Mbps.

Also take note of wild swings in performance between tests. That's a sign your internet connection works but is unreliable.

Suspect that connection is the problem? Check our guide to fixing a wired internet connection if you use ethernet (go.pcworld.com/fxin), or our guide to fixing Wi-Fi problems for wireless (go.pcworld.com/fxwf).

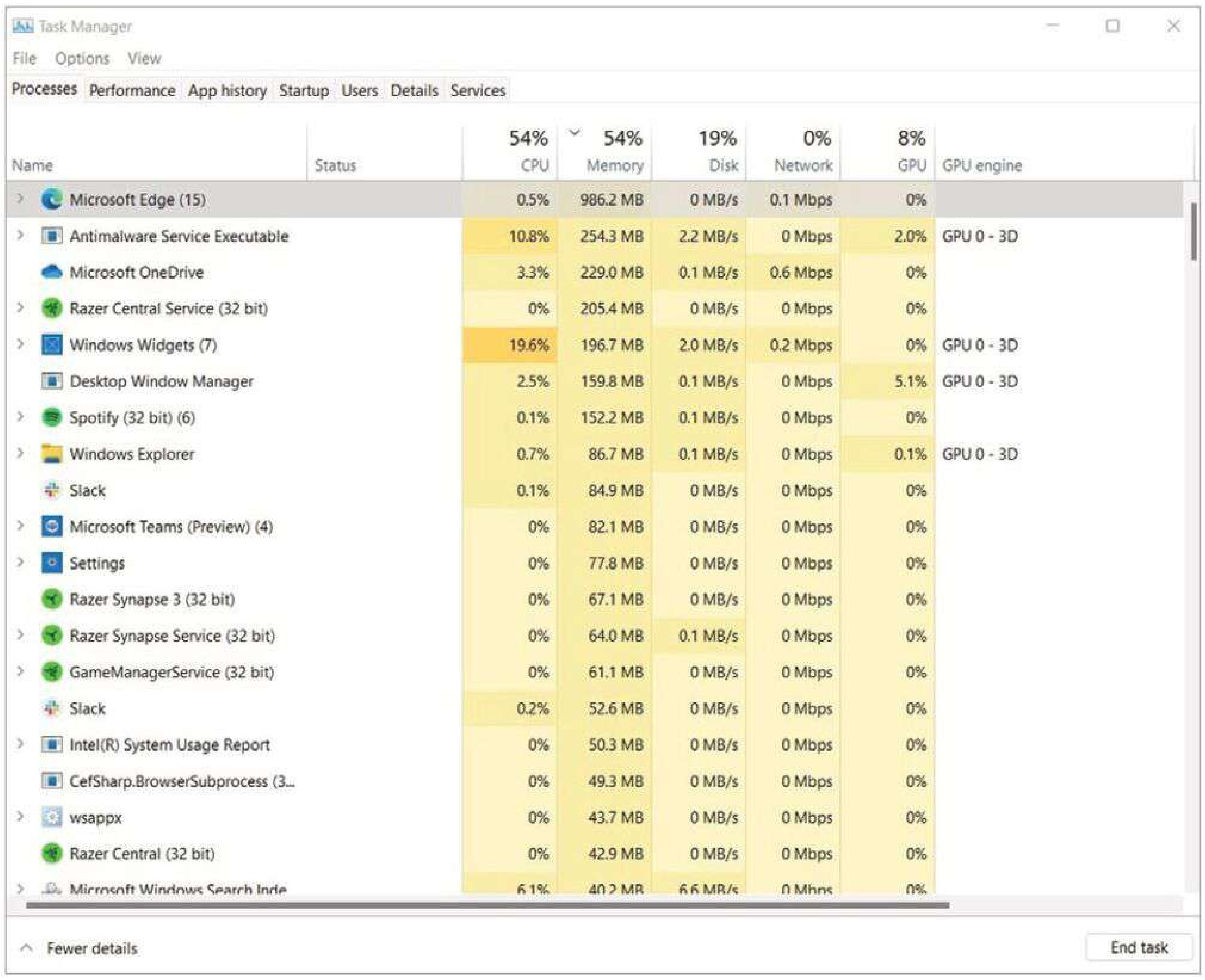
4. FREE UP RAM

Your laptop's random access memory, or RAM, is its short-term memory. It keeps track of active applications and the data they need. A laptop that runs out of RAM must instead draw data directly from the hard drive, which, even in the case of a modern solid state drive, takes more time.

You can see active programs, and the memory they consume, with Task Manager (go.pcworld.com/tsmn). You can launch this from Windows Search or by pressing Control + Alt + Delete on your keyboard and selecting Task Manager from the menu that appears.

Task Manager will open a list of active programs. Select More Detail to see the amount of memory each program is using. Select applications that appear to use a great deal of memory and select End Task to close them. Be warned that this will completely (and instantly) close the app, and you may lose unsaved data.

Freeing up RAM with Task Manager is a temporary fix. It can help you root out RAM hogs, but it's likely the apps you had open were open for a reason. Still, this can work while you search for alternative apps that use less memory or while you plan a RAM upgrade.



Name	Status	54% CPU	54% Memory	19% Disk	0% Network	8% GPU	GPU engine
Microsoft Edge (15)		0.5%	986.2 MB	0 MB/s	0.1 Mbps	0%	
Antimalware Service Executable		10.8%	254.3 MB	2.2 MB/s	0 Mbps	2.0%	GPU 0 - 3D
Microsoft OneDrive		3.3%	229.0 MB	0.1 MB/s	0.6 Mbps	0%	
Razer Central Service (32 bit)		0%	205.4 MB	0 MB/s	0 Mbps	0%	
Windows Widgets (7)		19.6%	196.7 MB	2.0 MB/s	0.2 Mbps	0%	GPU 0 - 3D
Desktop Window Manager		2.5%	159.8 MB	0.1 MB/s	0 Mbps	5.1%	GPU 0 - 3D
Spotify (32 bit) (6)		0.1%	152.2 MB	0.1 MB/s	0 Mbps	0%	
Windows Explorer		0.7%	86.7 MB	0.1 MB/s	0 Mbps	0.1%	GPU 0 - 3D
Slack		0.1%	84.9 MB	0 MB/s	0 Mbps	0%	
Microsoft Teams (Preview) (4)		0%	82.1 MB	0 MB/s	0 Mbps	0%	
Settings		0%	77.8 MB	0 MB/s	0 Mbps	0%	
Razer Synapse 3 (32 bit)		0%	67.1 MB	0 MB/s	0 Mbps	0%	
Razer Synapse Service (32 bit)		0%	64.0 MB	0.1 MB/s	0 Mbps	0%	
GameManagerService (32 bit)		0%	61.1 MB	0 MB/s	0 Mbps	0%	
Slack		0.2%	52.6 MB	0 MB/s	0 Mbps	0%	
Intel(R) System Usage Report		0%	50.3 MB	0 MB/s	0 Mbps	0%	
CefSharp.BrowserSubprocess (3...		0%	49.3 MB	0 MB/s	0 Mbps	0%	
wsappx		0%	43.7 MB	0 MB/s	0 Mbps	0%	
Razer Central (32 bit)		0%	42.9 MB	0 MB/s	0 Mbps	0%	
Microsoft Windows Search Inde		6.1%	40.2 MB	6.6 MB/s	0 Mbps	0%	

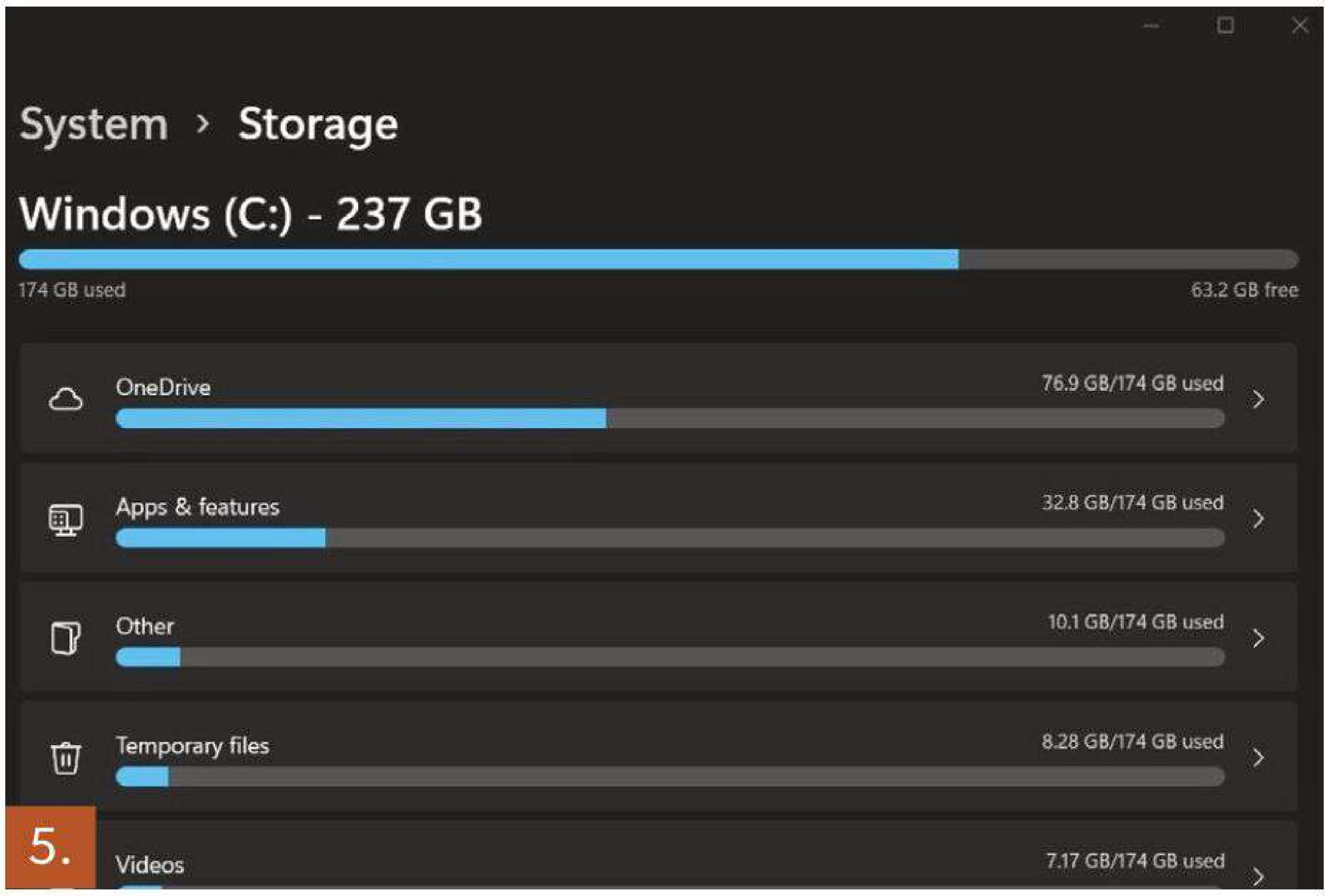
Windows 10's Task Manager.

5. FREE UP SPACE ON YOUR HARD DRIVE

Your hard drive is your laptop's long-term memory, and it too will cause problems when filled to capacity. You won't be able to install new applications, of course, and you may notice a general malaise. This happens because many apps, and Windows itself, need a bit of space to store temporary files.

You can check your laptop's storage by opening Windows' Settings and selecting System, and then Storage. Windows will display a bar graph showing how much storage is used. The bar will be red if your hard drive is too full.

This same menu also provides a list of how your storage is used. This includes apps, temporary files, video, music, OneDrive files, and more. You can select each to not only see a breakdown of what's taking up space but begin removing apps or emptying temporary storage. Apps & features nearly always take up the most space, so browsing that



5.

System › Storage

Windows (C:) - 237 GB

174 GB used 63.2 GB free

OneDrive 76.9 GB/174 GB used

Apps & features 32.8 GB/174 GB used

Other 10.1 GB/174 GB used

Temporary files 8.28 GB/174 GB used

Videos 7.17 GB/174 GB used

section and uninstalling large apps is the most effective way to free up space.

The Windows' Storage menu is not perfect, however. It can fail to detect programs, in which case they'll be listed under Other instead of Apps & features. Be sure to check both.

Our guide to freeing up space on a laptop hard drive has more space-saving tips (go.pcworld.com/fsph).

6. RUN WINDOWS UPDATE

Windows Update may improve performance by updating your laptop's drivers or installing a new version of Windows that resolves issues found in a previous version.

By default, your laptop should run Windows Update regularly, which means you won't have updates to install. You may have put off your updates, however, or disable the feature entirely. Windows users often do this after tiring of Windows Update's frequent reminders.

You can run Windows Update by opening the Windows Settings menu and then selecting Updates & Security. This will launch your system right into Windows Update. Download and install pending updates. Most updates require that you restart the laptop to finish installation.

7. RESET WINDOWS

Is your laptop still annoyingly slow? It's time to pull out and nuke the site from orbit.

Resetting Windows is an extreme step but often helps with performance issues. You're effectively returning the laptop to its factory-default settings. This can resolve application, Windows configuration, and device driver issues that are causing performance problems.

Our guide to resetting Windows provides the details (go.pcworld.com/rstw). Fortunately, the steps are fairly straightforward. Open the Windows' Settings app, select Updates & Security, and then select Recovery. "Reset this PC" sits at the top of this menu. Press Get Started and then just follow the on-screen instructions.

Make sure to back up all important files before you reset Windows. The reset can take some time on older hardware, so you should plan to have your laptop out of commission for the day.

8. UPGRADE YOUR LAPTOP'S RAM

Is your laptop still sluggish? A hardware upgrade could be your only hope.

Adding RAM will fix sluggish performance caused by limited RAM capacity. While you can close programs to free up RAM, as previously suggested, adding more RAM is the best long-term solution.

Unfortunately, this isn't always possible. Modern laptops may permanently fix RAM to the mainboard or may seal the laptop in a way that makes an upgrade difficult or impossible without special tools. Check your laptop manual to find out whether an upgrade is possible.

Our guide to upgrading your laptop's RAM will help you navigate the details of purchasing and installing new RAM (go.pcworld.com/lprm).

9. UPGRADE TO A SOLID STATE DRIVE

Most current laptops are sold with a solid state drive (SSD), but some recent models were available with a mechanical spinning disk, also known as a hard disk drive or HDD. Disk drives offer a lot of storage at a low price but are much, much slower than SSDs. You'll be waiting every time your system needs to access data from the hard disk.

As is the case with RAM, not every laptop is built to allow a user hard drive upgrade. Having said that, laptops that shipped with an HDD are likely to support an upgrade. You can check your laptop's manual to find out more.

Our guide to adding an SSD to your laptop will help you purchase and install the new drive (go.pcworld.com/adss), while our guide to the best SSDs can help you find a great one (go.pcworld.com/bsld).

Make sure that you back up important data (go.pcworld.com/wbku) before you begin. Most laptops don't support two hard drives. You'll have to replace your current drive to install the new one.

IS YOUR LAPTOP STILL SLUGGISH? IT MIGHT BE TIME TO REPLACE IT.

With luck, these tips will help you resolve your laptop's performance issues. If not, it's time to consider a new laptop. Our laptop reviews will point you in the right direction (go.pcworld.com/lprv).

We also have suggestions for ways to repurpose an older laptop (go.pcworld.com/rpur). Remember, don't just toss it in a landfill! Laptops include materials that can be hazardous if released, and the lithium-ion battery can catch fire if damaged. You can recycle a laptop, often at no cost to you, by dropping it off at a local recycling center or contacting the manufacturer.

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IMAGE: ZOOMIK/SHUTTERSTOCK

WHAT IS DDR5? THE PC'S NEXT-GEN MEMORY, EXPLAINED

EVERYTHING YOU NEED TO KNOW ABOUT THE PC'S NEXT RAM STANDARD.

BY GORDON MAH UNG

Major changes to the PC's RAM subsystem typically occur once in a blue moon, but mere years after DDR4's delayed rollout, that time is upon us yet again.

With the imminent release of DDR5 support in Intel's Alder Lake CPUs (see page 9) next month (and potentially AMD's Zen 4 chips next year), we'll soon be entering a junction where you'll need to decide what memory is right for you—DDR4 or DDR5.

How fast is DDR5? What will I need to run what? What even *is* DDR5? By the end of this guide, you'll know everything you need to make the right decision.

WHAT IS DDR5?

DDR5 is the next evolution of PC main memory. This version is primarily focused on increasing the density and bandwidth of RAM while lowering its power consumption.

HOW MUCH DDR5 RAM CAN I PUT IN MY PC?

With today's DDR4 technology, the largest consumer modules top out at 32GB. DDR5 can quadruple that capacity. A typical mainstream PC with four DDR4 DIMM slots will max out at 128GB. A cutting-edge system built around four DDR5 DIMM slots can reach 512GB. And even higher-end systems with eight DDR5 DIMM slots should be able to reach a ludicrous 1TB of RAM.

DO I REALLY NEED 512GB OF RAM IN MY PC?

No, most consumers and gamers don't really need more than 16GB to 32GB of memory today. All PCs are personal, though—hence the name—and for every 29 people who don't need more than 16GB of RAM, there's probably one person who does and who would be glad to have 512GB for some esoteric scientific, research, or extreme imaging reason.

HOW MUCH MORE MEMORY BANDWIDTH WILL DDR5 GIVE ME?

RAM manufacturer Micron said it's seeing a 36 percent increase in bandwidth with a DDR5 module versus a DDR4 module at the same data transfer rate of 3200 MT/s. A DDR5/4800 module Micron tested would offer an 87 percent increase in performance against a similar DDR4/3200 module.

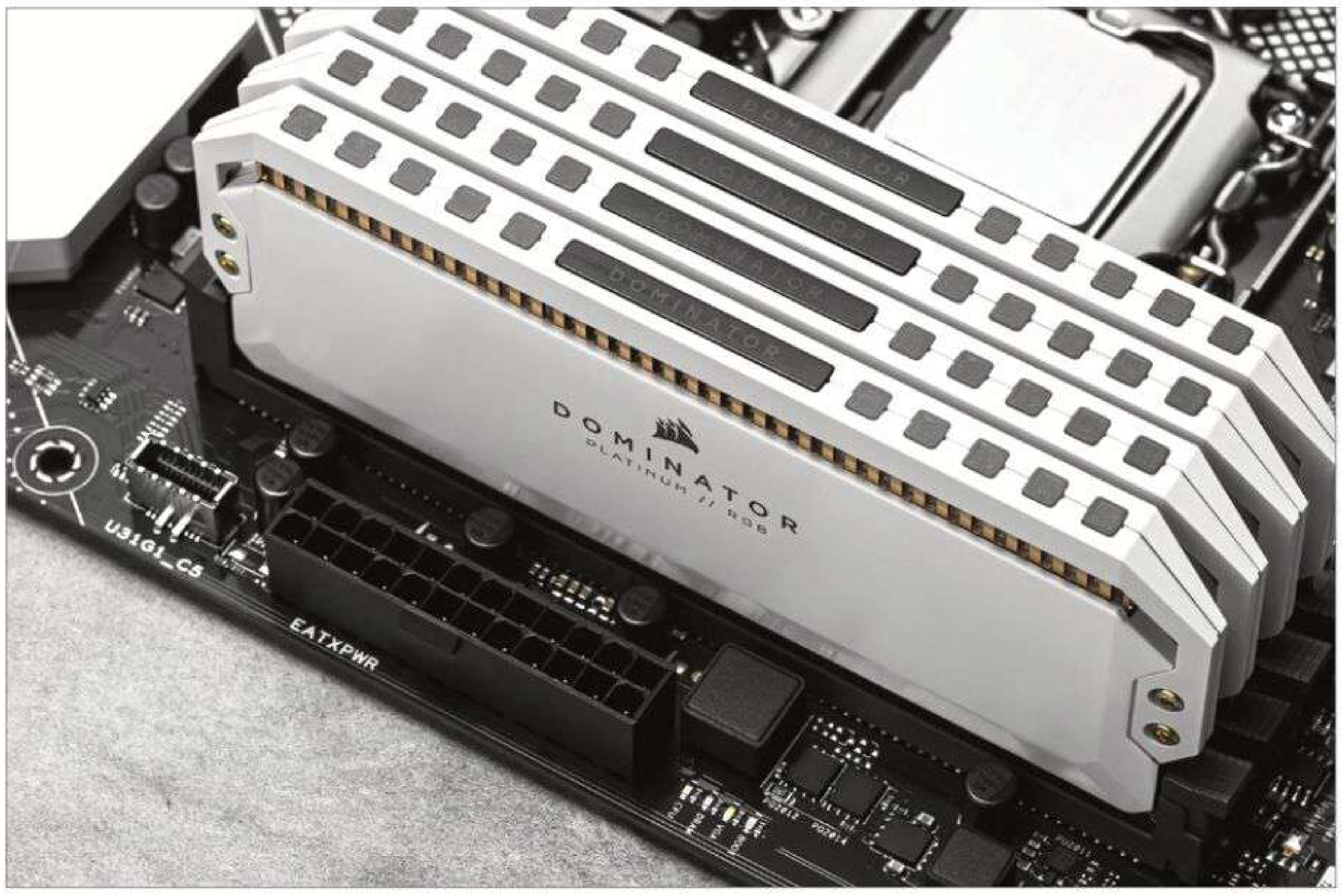
DOES DDR5 LOWER LATENCY?

Despite all these improvements, DDR5's memory latency is overall about the same as DDR4's, according to Corsair officials. They're indicating that single-access latency is about the same, with column-access strobe latency slightly worse. Corsair's guidance so far is that overall latency of a "top-tier" DDR5 module will be about the same as that of a DDR4 module in the 14ns to 15ns range.

I CAN ALREADY BUY DDR4/5333 MODULES, SO WHAT'S THE BIG DEAL?

It's true that you can buy DDR4/5333 memory modules today (go.pcworld.com/dr53), but those are all technically beyond the official limits for the memory, which is DDR4/3200. Module makers typically reach those higher data rates by overclocking the RAM, which also technically requires voiding the warranty of AMD and Intel CPUs. Neither company really cares if you do so, but it is *technically* outside the limits of DDR4.

DDR5, on the other hand, has seen DDR5/4800 modules from day one (go.pcworld.com/dr48), with DDR4/6400 modules around the corner. Adata has said it may see overclocked modules reaching DDR5/12800, too. And all this speed talk doesn't factor in Micron's testing, which



The Corsair DDR5 RAM.

shows that at the same data rate, DDR5 offers 37 percent more bandwidth than DDR4.

WILL DDR5 COST MORE?

As with any new technology, you can expect DDR5 to cost more than today's comparable DDR4 modules. RAM maker Samsung has said that we should expect DDR5 to cost at least 30 percent more at introduction. Keep in mind that cost is just for the chips themselves.

When Team Group offered up a 32GB DDR5/4800 pair, the pre-order price in late June was $311 on Amazon (go.pcworld.com/am31). A comparable Team Group set of 32GB DDR4 modules fetched from $150 to $180, according to PCMag (go.pcworld.com/acor).

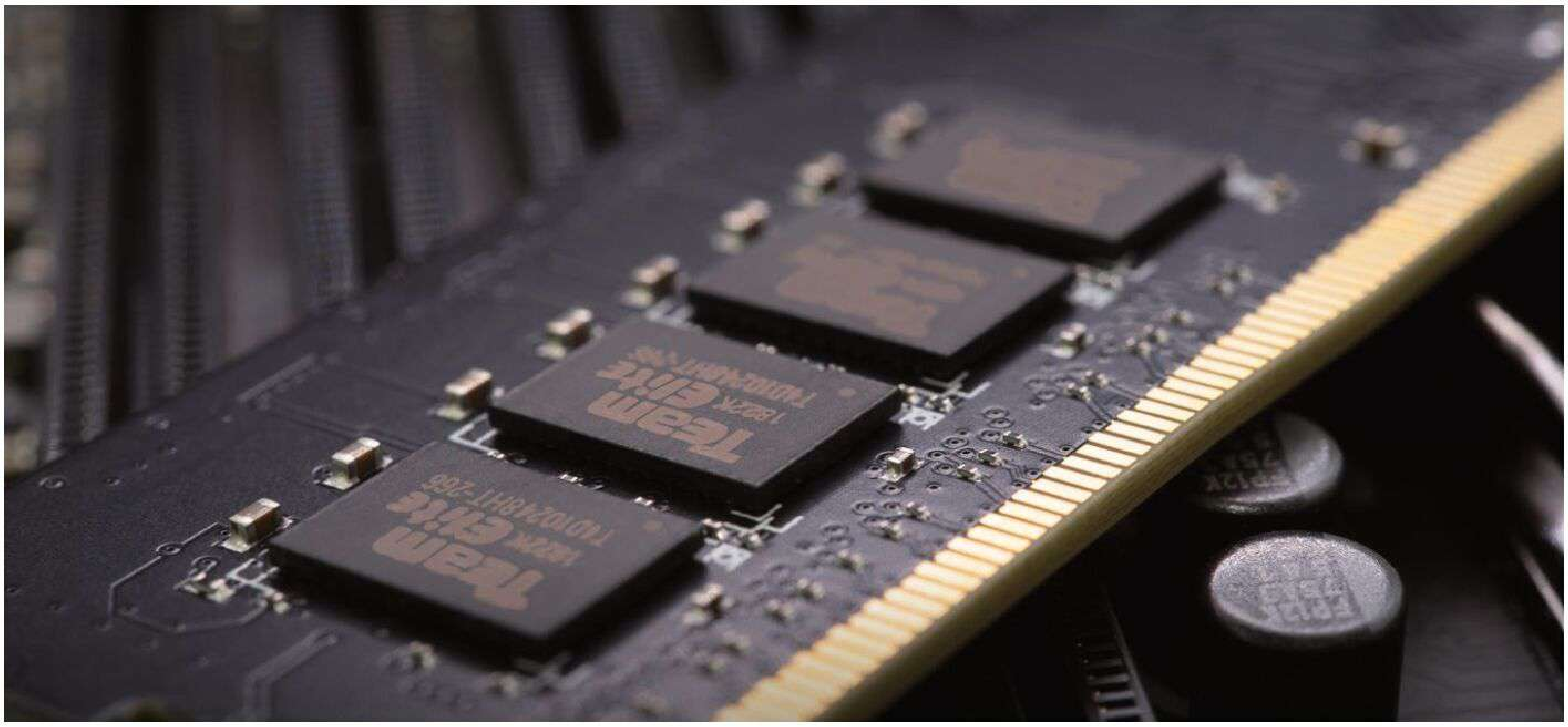
So yes, early DDR5 adopters will need to cough up some pretty pennies. Remember that it's always been like with transitions to new memory options. Shiny new things almost always cost more at first.

WILL DDR5 BE HOTTER?

With the greater bandwidth and higher capacity, DDR5 will also add heat to the mix—but it's not necessarily due to the chips themselves running hotter. With DDR5, voltage regulation for the RAM will move directly into the module itself. With DDR4, the voltage for the RAM is located on the motherboard.

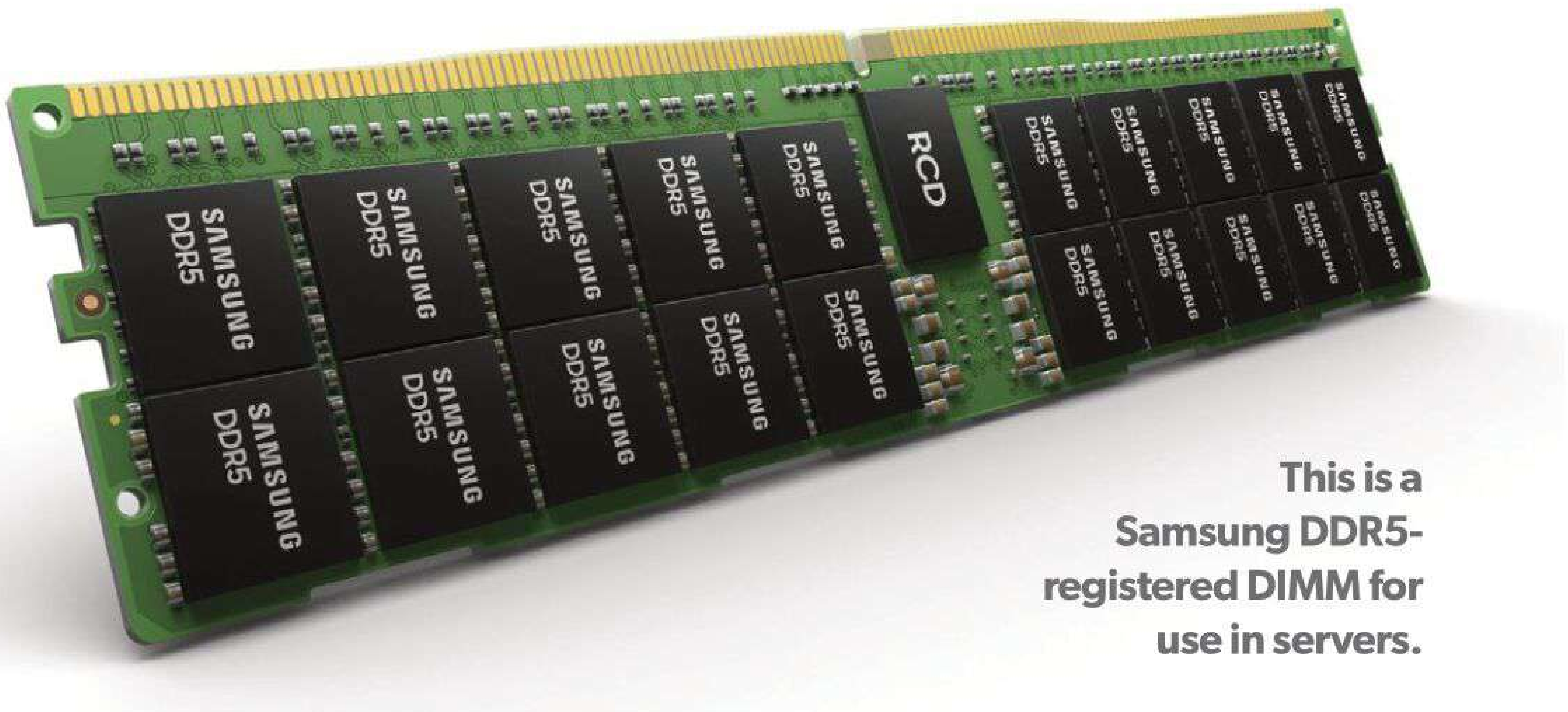
In theory, this should reduce the complexity of the motherboard and give the individual module maker more control, as well as the ability to optimize power delivery for each module.

The price for that is additional heat created on the module itself, and that heat



When Team Group offered up a 32GB DDR5/4800 pair, the pre-order price in late June was $311.

needs to be dissipated. Module maker Corsair, for example, is already touting its existing cooling design as an advantage for DDR5.



This is a Samsung DDR5-registered DIMM for use in servers.

DO ALL DDR5 MODULES HAVE ECC?

DDR5 does indeed include error correction control (ECC), which can detect multibit errors and correct single-bit errors. However, it's not what you're expecting if your workload already requires the technology.

With traditional ECC, error detection and control is performed at all levels, including on the data transferred to the CPU. With DDR5, ECC is integrated into each actual RAM chip, but once it leaves the chip and begins its journey along that long narrow wire to the CPU, no ECC is performed, meaning errors introduced along the way aren't its problem.

So why do this at all? It's mostly done because you can't really quadruple the density of the chip without additional safety layers. Today, you'll mostly only find ECC used in servers and workstations, because it's required for mission-critical reasons. The on-die ECC in DDR5 is just something that was necessary to make the high speed and high density a possibility.

The upshot is consumers will likely still not have "full" ECC RAM support (though whether that's needed is up for debate), while commercial CPUs and RAM will still offer full ECC support.

CAN I RUN DDR5 ON MY CURRENT SYSTEM?

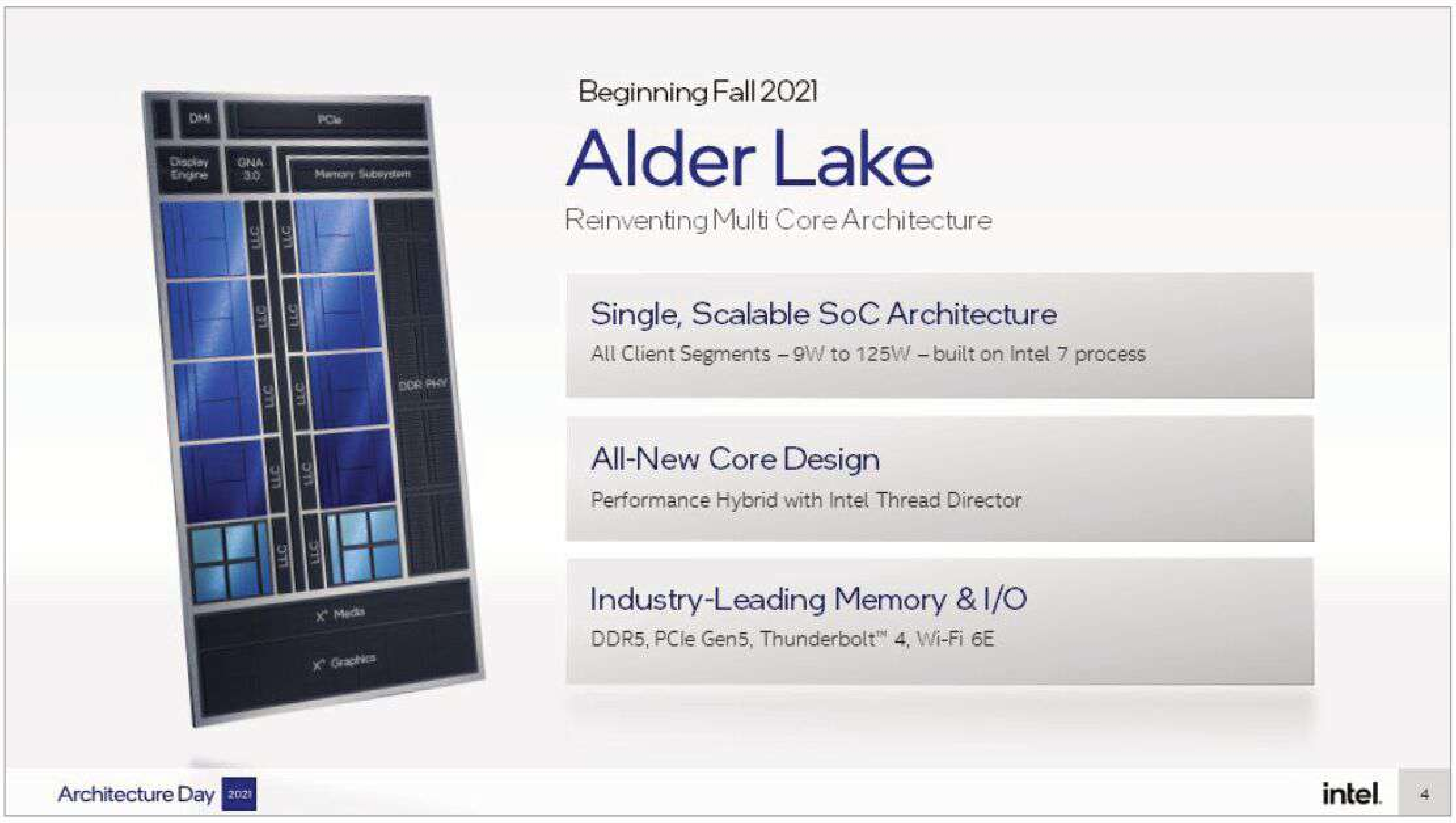
No. To run DDR5, you'll need a new CPU, a new motherboard, and new RAM.

WHAT CPUS WILL SUPPORT DDR5?

Intel's 12th-gen Alder Lake S CPUs will be the first out the door with support for DDR5 this fall, with AMD expected to support DDR5 with its Zen 4 CPUs in 2022.

CAN I USE A 12TH-GEN ALDER LAKE S CPU WITH OLDER DDR4 RAM?

Intel's 12th-gen Alder Lake S chips actually support both DDR4 and DDR5 (along with low-power versions). Intel is likely to launch Alder Lake with DDR5 motherboards, but knowing that new technology means higher



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Intel's 12th-gen Alder Lake S chips support both DDR4 and DDR5.

prices and lower availability, motherboards that also support 12th-gen Alder Lake and current DDR4 memory will very likely remain common for at least the first year or two after DDR5's release.

IS DDR5 MORE FUTURE-PROOF?

This is a very tricky question, but in general, paying the high price of new technology because it's "future-proof" rarely pays dividends. In October 2021, DDR5 is likely to be very expensive compared to DDR4, so it's typically better to wait for prices to equalize before jumping in—but much of this depends on what you value.

It also depends on how you see your investment in RAM. Paying a premium for DDR5 in 2021 or early 2022 means you can use that RAM when building a new system in 2026 (when you'd have to toss the DDR4). But typically it's better to upgrade to a new memory standard a few years after it drops, when the RAM will be larger, faster, and cheaper.

WILL NEXT-GEN CPUS BE FASTER WITH DDR4 OR DDR5?

We really have no answer to this right now. We *can* say that during previous memory transitions, the price premium was rarely worth it to those looking for practical impacts. That was typically due to the newer RAM typically starting very conservatively with speed and timings, with the older RAM benefiting from years of being pushed as fast as it could go.

DDR5 somewhat changes that, as it looks like it will offer superior bandwidth out the gate even compared to the fastest DDR4 modules. Even so, greater memory bandwidth doesn't always pay the dividends people expect outside integrated graphics performance (go.pcworld.com/rzn7).

Basically, we'll have to wait and see.

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AM I OKAY TO DRIVE?

BUZZED DRIVING IS DRUNK DRIVING

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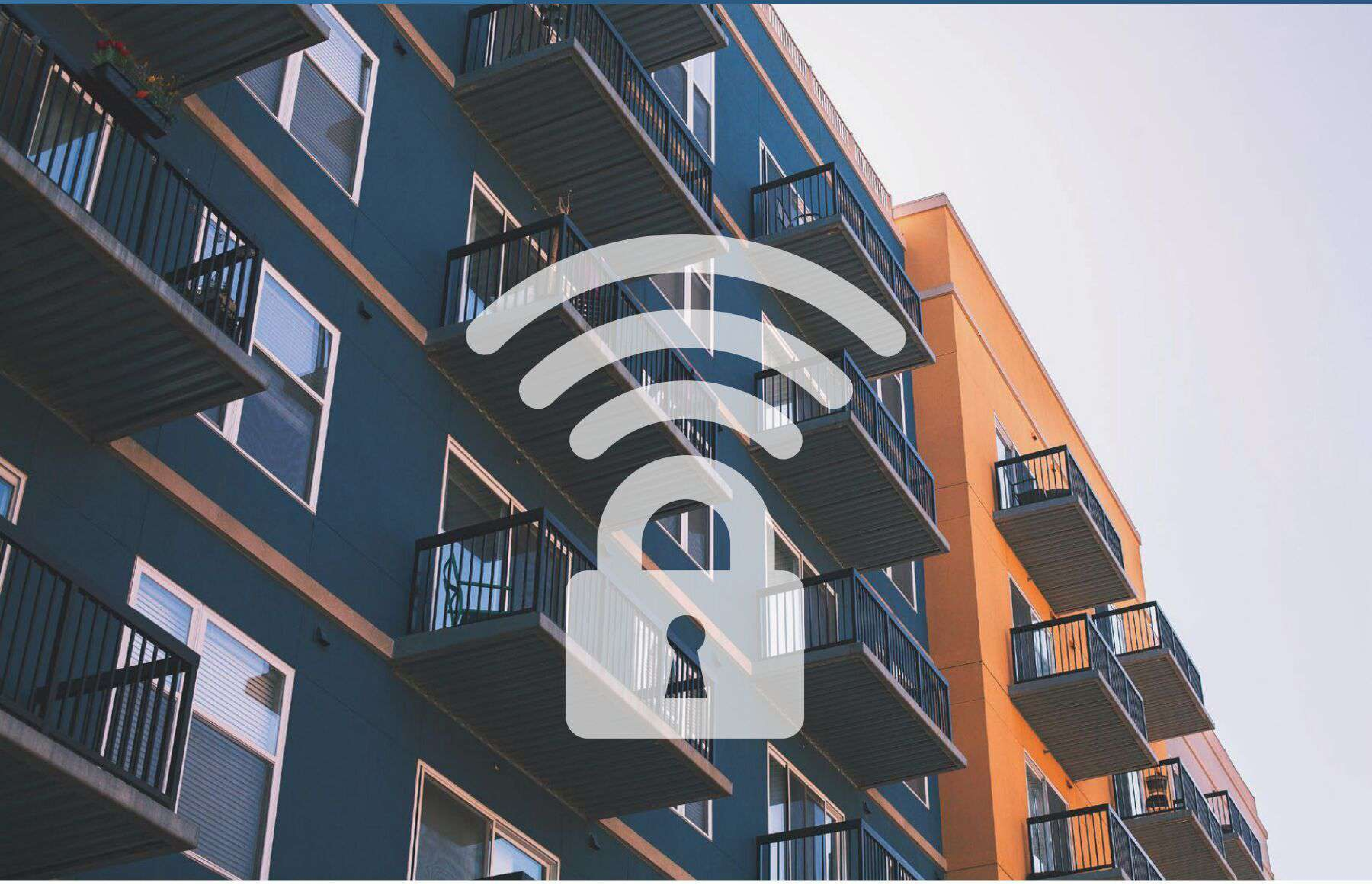


How to secure your home Wi-Fi network and router

Make sure what happens on your network stays private on your network. **BY ALAINA YEE**

Your home network's security is only as good as the configuration of your router or gateway. Leave it open or vulnerable, and you might end up with freeloaders that hog your bandwidth, in the best-case scenario. At worst, a snoop might take the opportunity to examine your internal traffic, hoping to discover sensitive information about you that can be exploited.

To ensure that only approved devices are connected to your network, you can take a few simple steps to strengthen its security, which we explain below. If you can't access some of these settings in your gateway (the combination modem/router provided by

IMAGE: BRANDON GRIGGS/UNSPLASH

your internet service provider), consider switching off the router part of it and using a dedicated router instead, of either the traditional or mesh variety.

CHANGE YOUR PASSWORDS

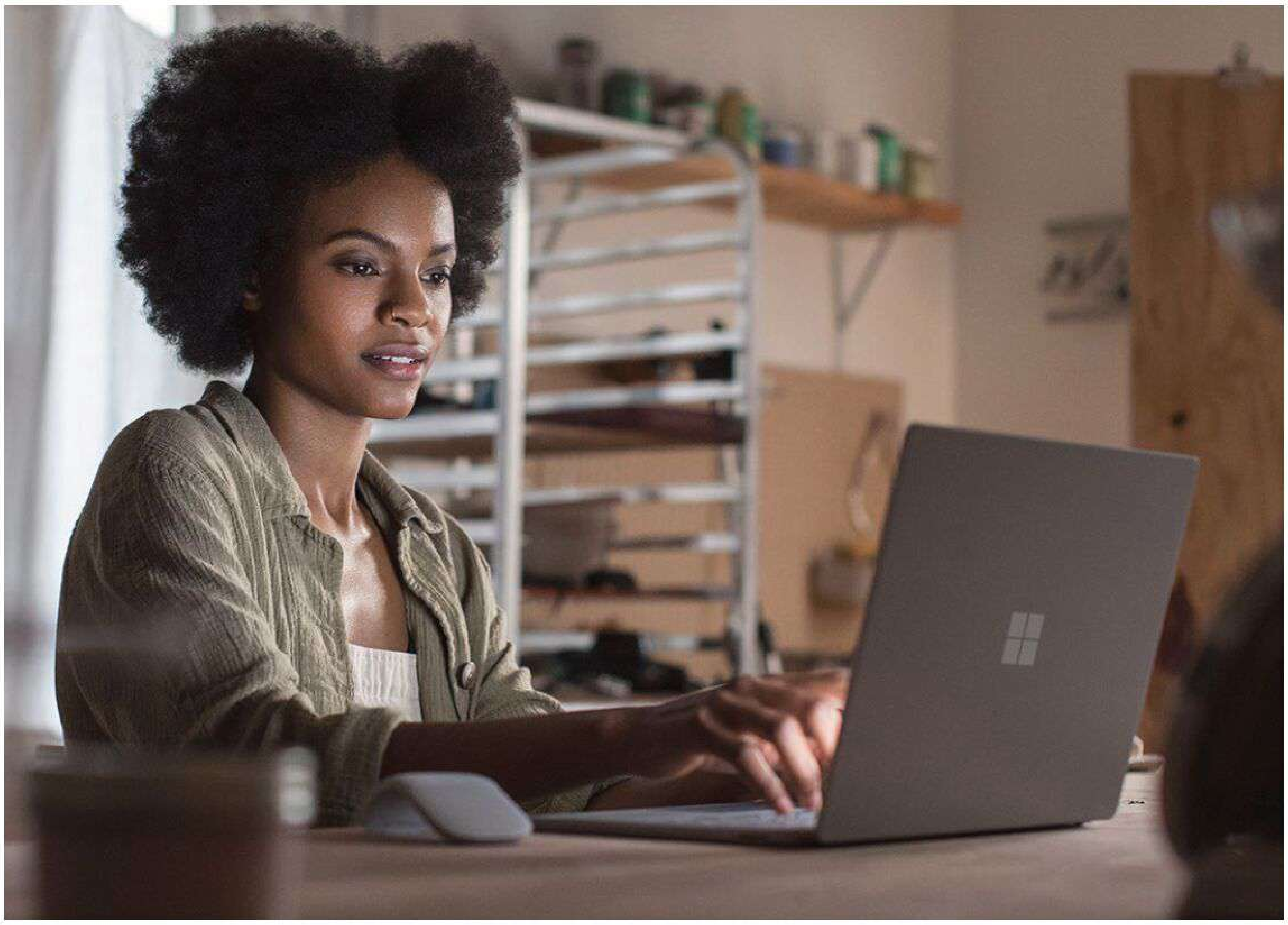
Depending on your router's age, you may need to change both the administrator password (which gives access to the management interface) and the Wi-Fi password.

Older routers usually default to ultra-simple passwords for the administrator account —think "admin" and "password"—and they're easily found online. You may have also chosen a simple, crackable password when turning on encryption for your network. For both scenarios, choose a new, stronger replacement. The best way to do this is a built-in password generator in a password manager (go.pcworld.com/bpmr)—they'll be truly random and thus more secure, and the manager will ensure you don't forget it. (Good free password managers [go.pcworld.com/fpmr] exist, so solid online security doesn't have to cost you a thing.)

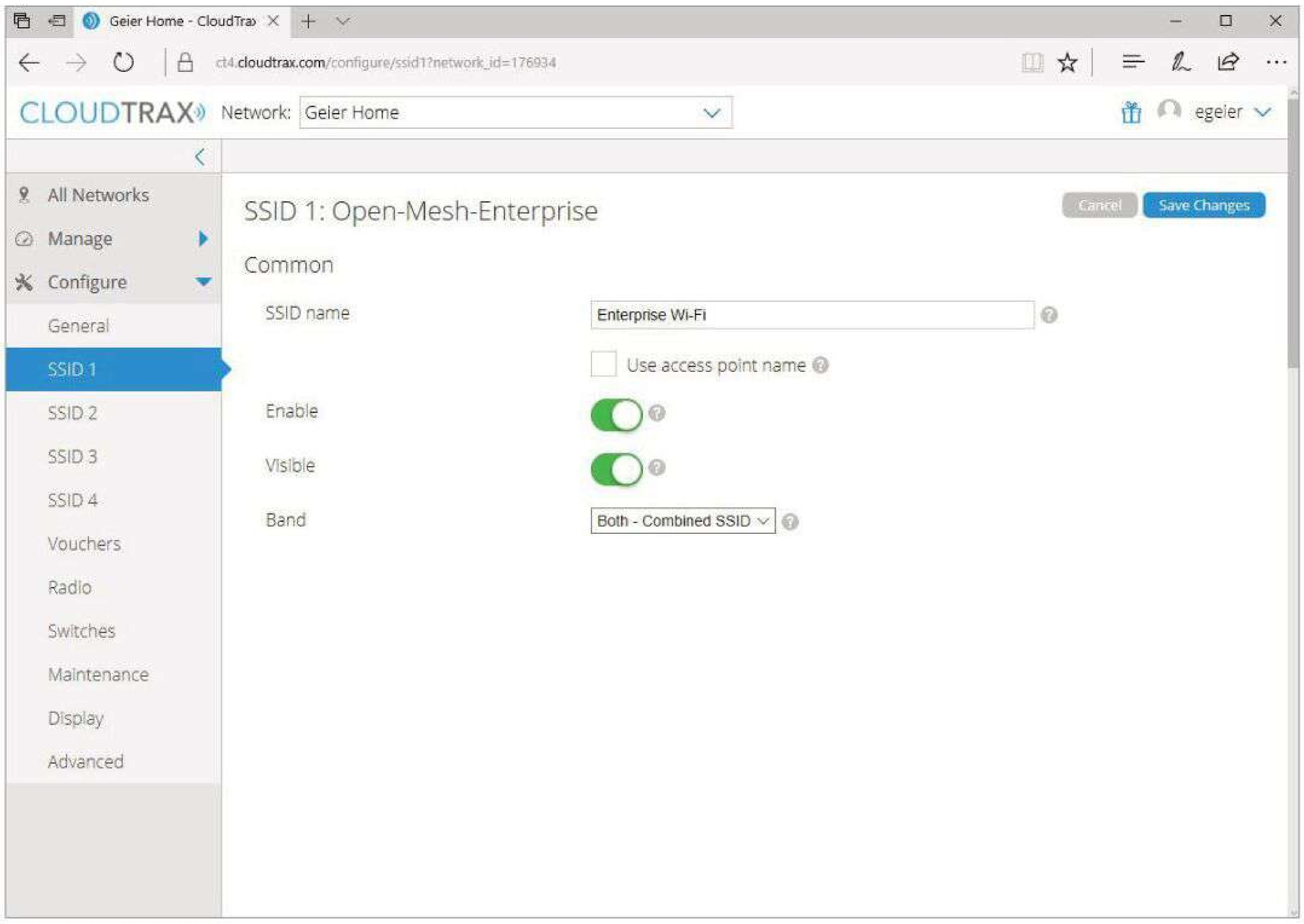
Newer routers often come with random passwords as a default. It doesn't hurt to change those passwords as well if your router or gateway has that information printed on it, though, particularly if you have less control over who might have physical access to the device. Just be sure to keep track of your new passwords, ideally in a password manager as mentioned.

ENABLE ENCRYPTION

You should always encrypt your network traffic. These days, choose WPA2 for the best security. Older protocols like WPA and the



Always encrypt your network traffic.


Geier Home - CloudTrax
ct4.cloudtrax.com/configure/ssid1?network_id=176934
CLOUDTRAX
egeier
All Networks
Manage
Configure
General
SSID 1
SSID 2
SSID 3
SSID 4
Vouchers
Radio
Switches
Maintenance
Display
Advanced
Cancel
Save Changes

Network: Geier Home

SSID 1: Open-Mesh-Enterprise

Common

SSID name: Enterprise Wi-Fi

☐ Use access point name

Enable: on

Visible: on

Band: Both - Combined SSID

Name your network wisely. It should be something generic but not too common that doesn't reveal your address.

ancient WEP won't adequately protect you. If your router supports the newer WPA3 protocol, you can try it out—it's an improvement over WPA2—but *all* of your connecting devices must support that protocol. Most people can stick with WPA2 for now, and then flip over to WP3 once all devices in the household can also make the leap.

When setting up WPA2 encryption, pick WPA2 Personal if given a choice between that and WPA2 Enterprise in your router settings. Also, if you see TKIP and AES as different encryption options, go with AES as it's much stronger.

For older devices that cap out at WPA, consider upgrading your router at last. You'll get better security, faster speeds, and more features for as little as $50 (go.pcworld.com/tpac) or less if you wait for a sale. If you're on an ancient router that only has WEP, replace it stat. You're barely one step above having an open network.

As for folks who leave encryption off because you want to share your internet with others: We salute your altruism, but don't let that come back to haunt you. As mentioned above, no encryption means people can spy on your internet traffic, giving them clues to your activities (including banking). That could lead to some troublesome problems down the road.

CHANGE YOUR SSID

A Service Set Identifier (SSID) is the name of a wireless network. That is what you see when trying to connect to a Wi-Fi network: Linksys616, D-Link2289, 555MainSt, We Have No Wi-Fi Here, and so on.

Because older routers default to ultra-simple or easily cracked passwords, changing the SSID to a non-identifying word or phrase helps thwart hackers looking for low-hanging fruit. Leave it as *linksys*, and a savvy snoop may realize you're running a much older Linksys router with "admin" as the password for router management. If you haven't changed that password (and most people don't), your home network is ripe for their exploration.

As you move forward in time, many routers use a combination of the manufacturer name and numeric string (often the model number) for the SSID—making it even easier to look up the default admin password. Unless you have a modern enough router that issues random passwords as part of the factory settings, you could be even more vulnerable. So just change the SSID. (Don't use your address for it, either. There's no need to make yourself more identifiable.)

Note: Years ago, a common recommendation used to be to not broadcast your SSID: that is, to keep it hidden from the list of available Wi-Fi networks in your vicinity. But trying to do security through obfuscation doesn't really work here—it's been proven that someone can easily discover hidden networks with a wireless spectrum scanner. Since disabling SSID broadcasting also makes it harder for people to join your network, you're generally better off leaving it visible, using the strongest encryption available to you, and creating a very strong Wi-Fi password.

TURN OFF REMOTE ACCESS

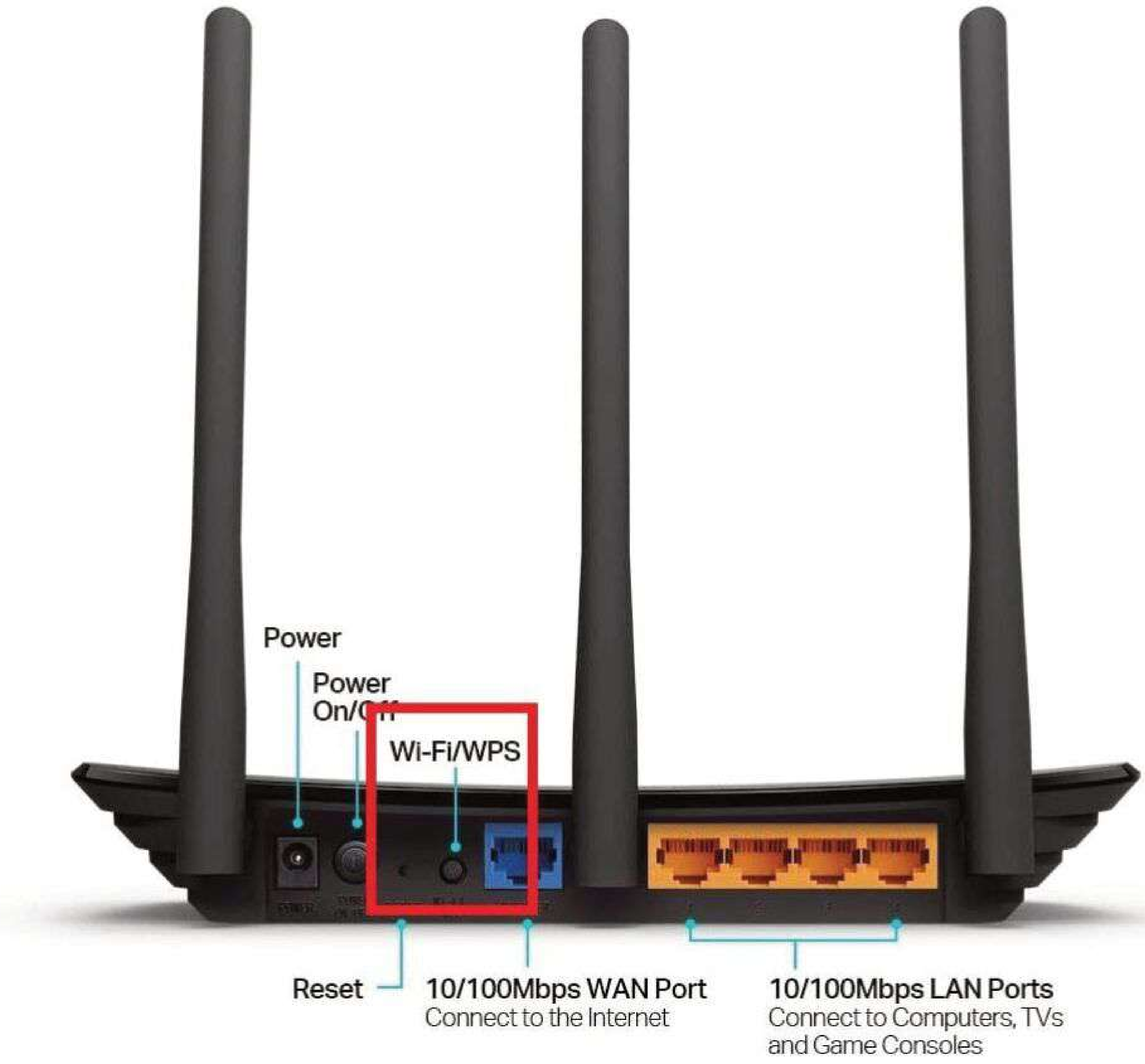
Some routers allow you to access the administrator account from outside your home network. Disable this feature. Extremely few people need to leave this on, and by turning it off, someone will have to be in range of your router and successfully connect to it to attempt mischief. You can then protect yourself against the latter scenario by enabling encryption, changing your SSID, and turning off WPS (detailed below).

DISABLE WI-FI PROTECTED SETUP (WPS)

WPA2 and the older WPA protocol require more complicated passwords for Wi-Fi access. So to simplify connecting to those types of networks, router manufacturers began offering Wi-Fi Protected Setup (go.pcworld.com/wfps), or WPS, as a feature. But it can be easily cracked, and so you should disable it despite its time-saving intentions.

Think of this feature as akin to setting both a password *and* another, less complex form of authentication on the same device. On a Windows 10 PC or a modern mobile device, that might be a personal identification number (PIN) or registering a fingerprint. Instead of entering your password, you can simply enter the shorter PIN or hold your finger against a reader.

WPS works similarly, except it's baked in as a default part of your settings. The two common methods for implementation are



On this older TP-Link router (circa 2010), you can activate WPS by pressing a button.

either an eight-digit PIN or a button you push on the router (physically or virtually) to authenticate a device and allow it onto your network. The PIN method is the more vulnerable of the two: Hackers can guess the PIN through brute force—and possibly lock up your router as the cracking happens, which effectively causes a denial-of-service attack on your network.

As for the push-button method, anyone with physical access to your router can still use it as a roundabout way to determine your Wi-Fi password—so if you're trying to keep access restricted, you can undermine your efforts by leaving this feature active.

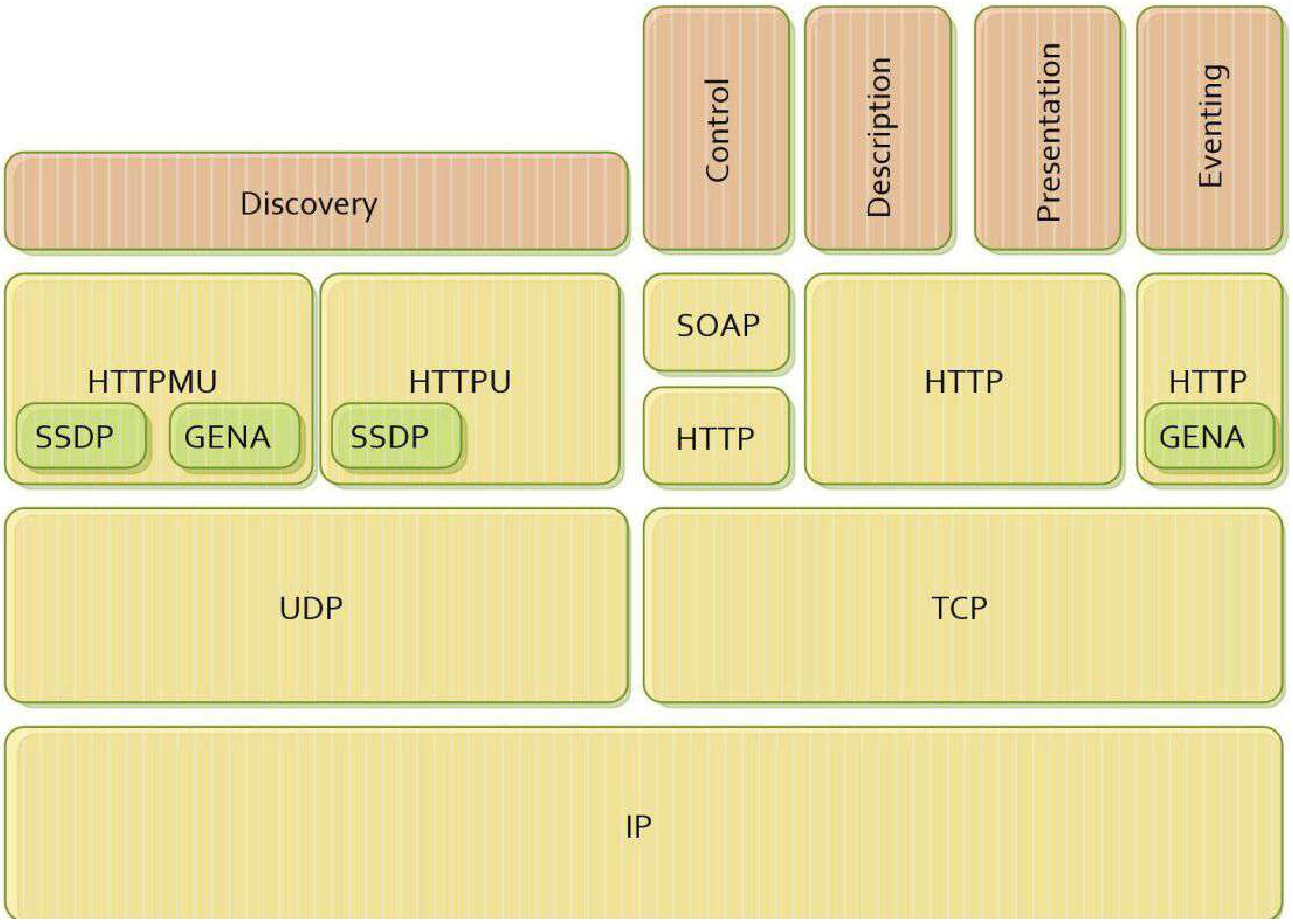
KEEP YOUR ROUTER'S FIRMWARE UPDATED

Over time, vulnerabilities can be discovered in your router's existing firmware. Performing regular updates will help patch those weaknesses—an easy win for home network security, since many routers have automatic notifications and updates built into the admin account's interface these days. Even if you have a router that doesn't make updates that simple, you can easily perform manual ones by going to your router's support page, and looking to see what the latest firmware version is. If a newer one is available, download it and then follow the instructions for applying the update to your router.

DISABLE UPNP (AND FEATURES THAT BYPASS FIREWALL PROTECTION)

Universal Plug and Play (UPnP) is a common feature on routers that allows network devices to find each other easily. As an extension of this, UPnP can help when you're trying to get VOIP services and online gaming on consoles working properly—it allows devices from other networks to access them. Some routers also have what the manufacturer might call a "Demilitarized Zone," or DMZ—a mode that allows all of a device's ports to be exposed to the internet. It's a more nuclear option than UPnP.

Any port exposed to the internet is a vulnerability. Windows has a built-in firewall for a reason: It protects your PC from



A technical diagram of UPnP architecture. As a home user, you don't need to dive this deep into the technical details for better network security. Just turn it off.

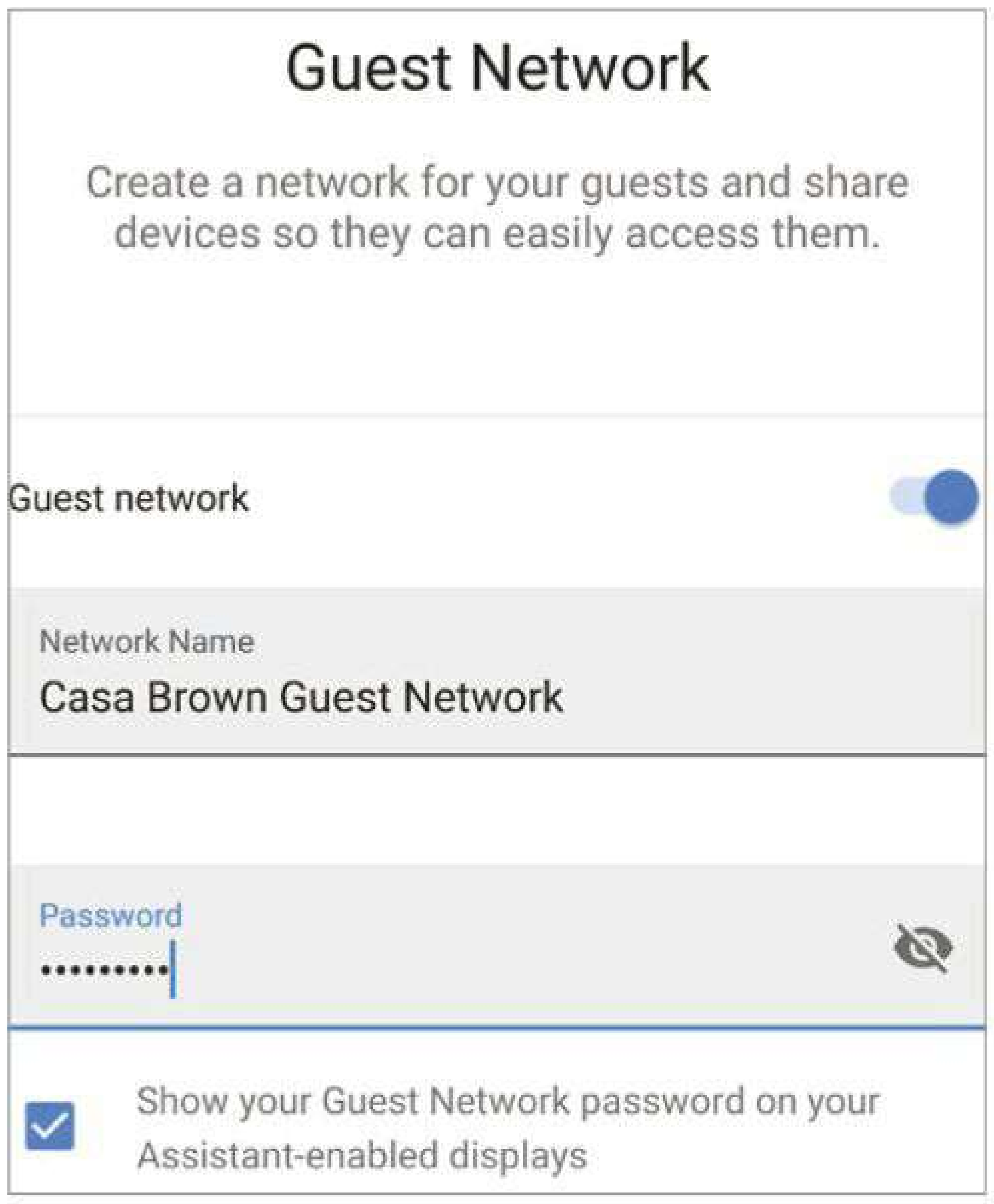
malicious actors trying to gain access, often in the hopes of using your machine to perform DDoS attacks. And if someone else is keeping your device busy, you won't be able to use it.

Avoid leaving ports open on a device, and disable any DMZ-like feature. UPnP is often not necessary either, so leave that off too. Instead, use manual port forwarding (go.pcworld.com/m4wd).

SET UP A GUEST NETWORK FOR SMART HOME DEVICES

A guest network is a feature on some routers that allows you to set up a separate SSID and password for access to your home network, and people on that network won't be able to see devices (and their traffic) on your primary network.

Segmenting your guests' internet access from your household's enables you to minimize snooping on the traffic of your home devices. A guest network is also a good hedge against insecure devices—like baby monitors, smart speakers, and other smart devices that can be put online but often don't have strong security to prevent their being taken over and then used in eavesdropping attacks.


Guest Network

Create a network for your guests and share devices so they can easily access them.

Guest network ●

Network Name
Casa Brown Guest Network

Password
••••••••

☑ Show your Guest Network password on your Assistant-enabled displays

An example of setting up a guest network from a simplified phone app interface.

EXTRA STEPS

Disable Wi-Fi access to your router's admin account

Most people don't log into their router's administrator account often. And on some routers, you can restrict admin account access to devices on a wired ethernet connection only. So if you want to really lock down those privileges, turn that feature on. Afterward someone would need both physical access and a wired device to manage your router.

This setting is most ideal for people logging into the admin account via a PC. Devices like phones and tablets can still work, but you'll need an appropriate dongle to connect an ethernet cable to the device.

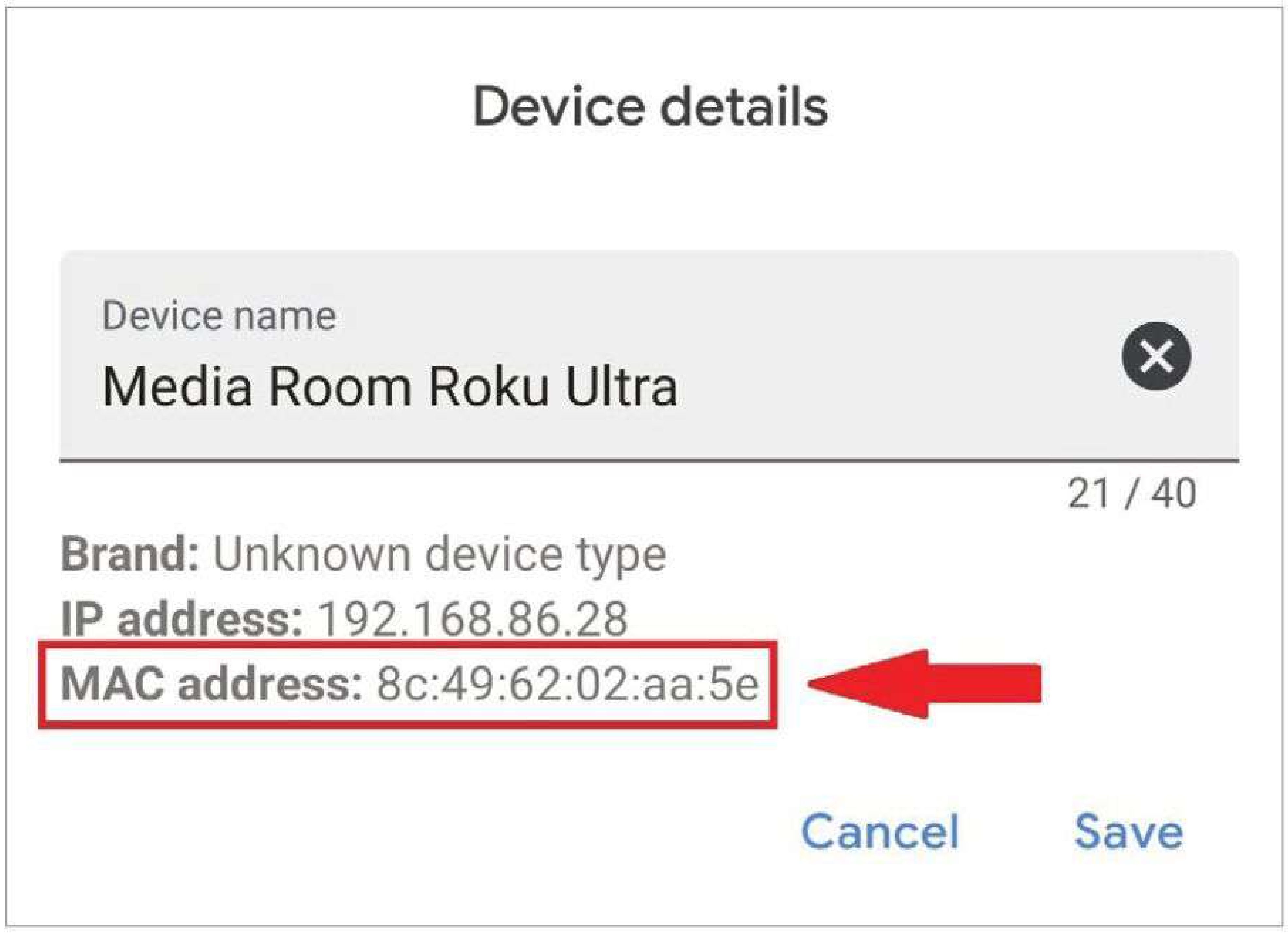
Enable MAC Filtering

All internet-capable devices have a Media Access Control (MAC) address—a unique string of alphanumeric characters formatted as six pairs of characters connected by colons. A MAC address is how your PC, phone, or other gear identifies itself to your router.

You can make Wi-Fi available to specific devices based on MAC addresses. In a process known as MAC filtering, your router grants access if a MAC address is on its allow list. Like a bouncer checking a VIP list, your router will bar any device not on that list from connecting—even when it provides the correct Wi-Fi password.

Be aware that MAC filtering is more of a hindrance to someone who wants unauthorized access to your network than an extra iron-clad layer of protection. MAC addresses can be spoofed. So any device faking the MAC address of a device on the allow list can still connect to your router with your Wi-Fi password.

MAC filtering at home can also make you less anonymous while you're out and about. The latest versions of Android and iOS use randomized MAC addresses to reduce your chances of being tracked by that identifier. Most people will choose to simply turn off that feature for MAC filtering, as the alternative is updating your router's allow list with the new MAC address each time you want to connect to the Wi-Fi at home.



Device details

Device name
Media Room Roku Ultra

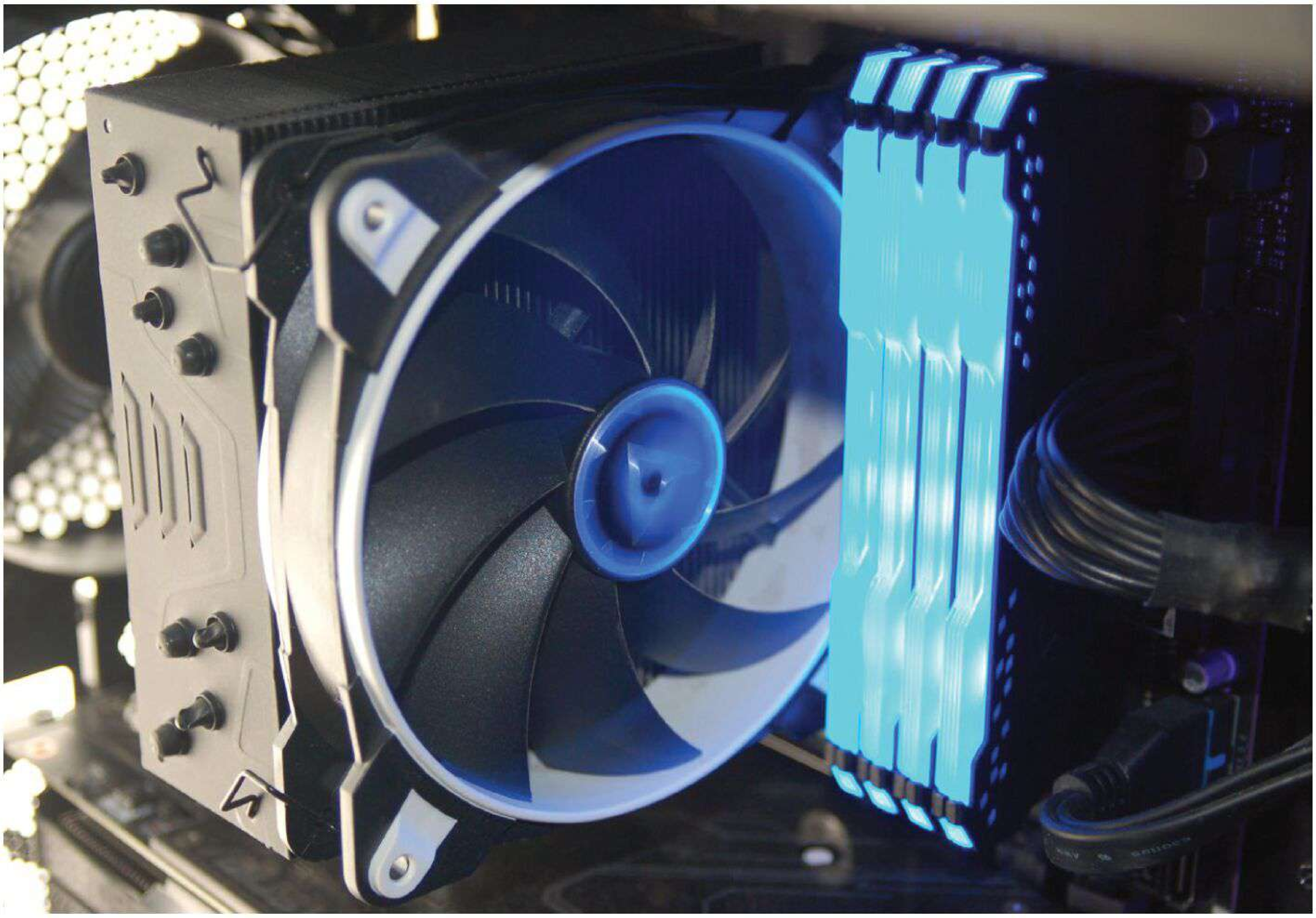
21 / 40

Brand: Unknown device type
IP address: 192.168.86.28
MAC address: 8c:49:62:02:aa:5e

An example of a MAC address.

How to keep your gaming PC cool for best performance

Keep your PC cool with these tips on how to lower the temperature. **BY IAN PAUL**



The desktop PC has two major nemeses: dust and heat. Heat can be tough to diagnose since you can't see it the way you can with dust. The key to avoiding any heat-related issues (besides regularly cleaning your PC [go.pcworld.com/clnp]) is sticking with some tried-and-true principles of cooling. If you follow the basics, then adapt them to your local environment and the demands of your PC, you should be just fine.

HOW TO MEASURE TEMPERATURES

The best way to easily measure if your PC is getting too hot is to monitor the temperatures reported by the CPU and GPU. If these two components are staying within their

IMAGE: BX PHOTOS/SHUTTERSTOCK

recommended temperature ranges, then everything else should be just fine.

For CPUs, this means keeping your processor under 80 degrees Celsius (176 Fahrenheit) when under load, but preferably much lower. A specific CPU's maximum operating temperature is often higher than that, but this is a good general benchmark.

There are many programs that let you monitor CPU temperature, but we recommend Core Temp (go.pcworld.com/crtm), as it's a lightweight program that does its job well. It will also report a temperature reading for each CPU core that you can see at a glance in your PC's system tray.

Graphics cards can get slightly toastier than the processor, but ideally they'd stay under 85 degrees Celsius (185 Fahrenheit). AMD and Nvidia's native software overlays can report your graphics card's temperature. Another option that will work for everyone is MSI's Afterburner (go.pcworld.com/aftr).

For more detailed explanations, see our guides on how to read your PC's CPU temperature (go.pcworld.com/cput) and GPU temperature (go.pcworld.com/gput).

INTAKE AND OUTTAKE

PC cooling starts with two case fans. You can have more than that, but you want at least two. Some cheaper desktops or PC cases only come with a single fan; you'll want to install another fan (go.pcworld.com/infn) if that's true of your system. One needs to be for intake that brings cooler air into the case. The other is for outtake or moving hot air out of the case. (Here's how to tell which way your PC fans are blowing [go.pcworld.com/fblw].) Having a single fan doing just one of those things will significantly increase temperatures.

Where these fans are situated depends on the case, but the outtake fan is usually positioned toward the back of the case, near the CPU. It can also be at the very top of the case, right above the CPU. This placement make sense because the CPU is outputting a lot of heat that needs to get out of the case, and the other major heat generator, the graphics card, is just below that.

The intake fan should ideally pull cool air in from the front of the case, away from where

A stack of Arctic P12 case fans.

the hotter components (and air) are. This all depends on your case, however, as your case design dictates fan placement.

If you only have a limited number of fans and they're not doing their job, an alternative is to look at pulse width modulation (PWM) fans. These fans, which require a compatible PWM header on the motherboard, make it possible to control the speed of the fans via software or your motherboard BIOS. This enables the fans to speed up when it's too hot and slow down (or even stop) when they're not needed. PWM fans are used on graphics cards for better power efficiency and cooling, and they can do the same for your system cooling needs.

You can find a basic no-frills PC case fan (go.pcworld.com/nofr) for as little as $5 on Amazon. Antec's whisper-quiet P12 case fans are an in-house favorite and you can get not one, not two, but five for under $25 (go.pcworld.com/un25). Meanwhile, if you want to add a little bling to your setup, you can also buy a five pack of Antec fans with RGB lights (go.pcworld.com/5rgb) and PWM support for $60. Our guide to installing case fans (go.pcworld.com/infn) has all the information you need to pick out the right kind for your particular setup.

Antec's RGB fans look great and will keep your PC nice and cool.

PRESSURE

Case fans are used to achieve one of several situations: positive pressure, negative pressure, or an even balance between the two. Positive pressure is when there is more cool air entering the case than exiting via the outtake fans. Negative pressure is the opposite.

PCs built without much attention to fan placement or direction usually end up with a positive pressure environment. That's because there are so many cracks, crevices, and unused vent holes in a PC case where air can enter. To get a negative pressure setup, where more air is pushed out than pulled in, you need to really think about fan placement and spin direction. You want most fans (if you have more than two)

Lenovo
LEGION

This illustration shows the flow of air through Lenovo's Legion C530.

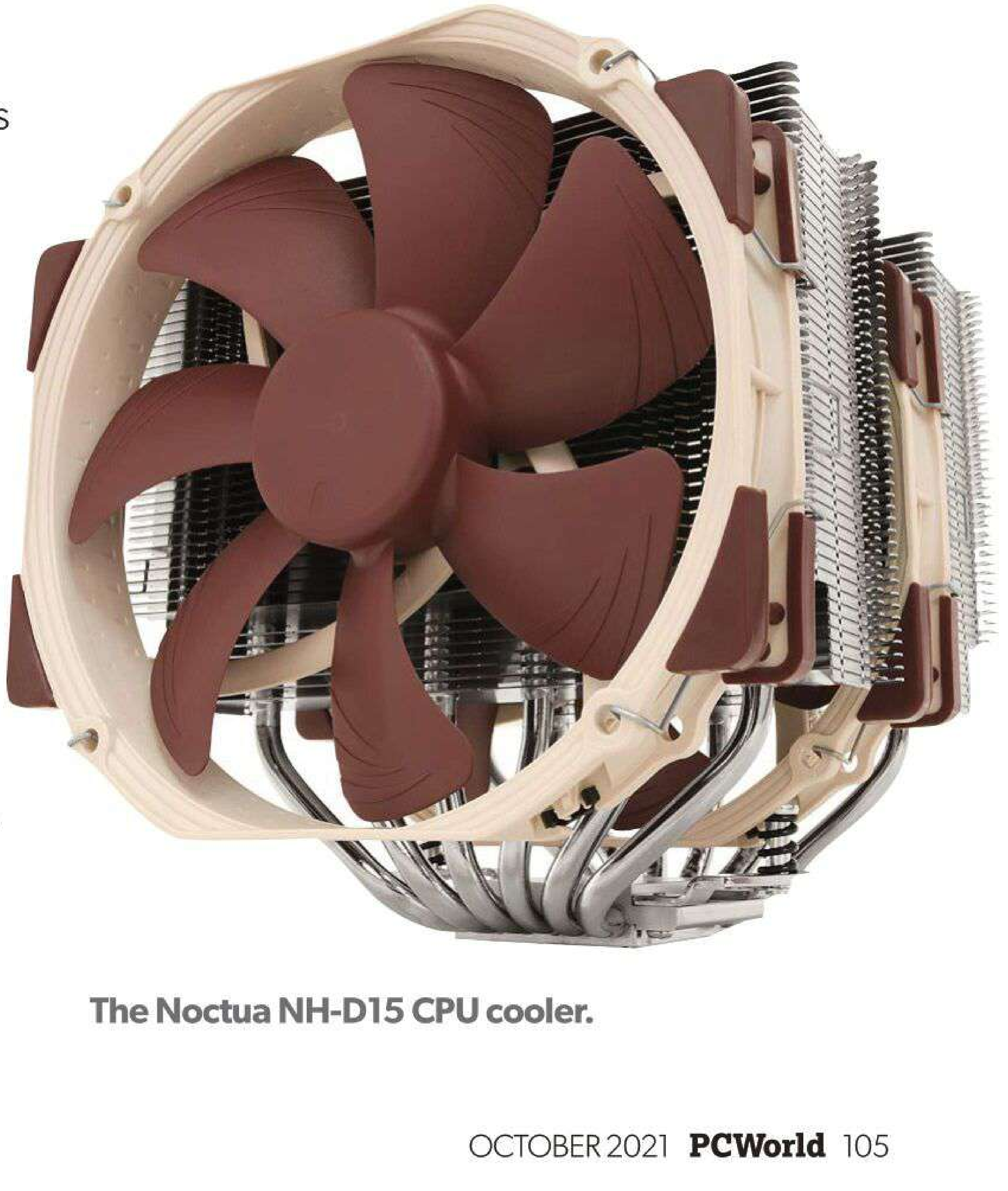
blowing outward to push all that hot air away from your components.

Which kind of pressure you want really depends on your needs. Some people in drier environments, where dust accumulates easily, swear by a negative-pressure environment for their PC. Other people aim for a positive airflow. An even flow of positive and negative pressure is the best bet for most people, however. When you have enough air moving through the case from the outside, while pushing really hot air out, you get the benefits of reducing dust accumulation while keeping the air moving. The key, however, is to make sure that you have filters near the intake fans to prevent too much dust from coming in with your air. If there aren't built-in filters for your case, you can often make your own filters without going to too much trouble.

UPGRADE YOUR COMPONENT COOLING

The key to any cooling setup beyond fans and airflow is the cooling devices you use for your GPU and CPU. Graphics cards come with their own fans. While you can upgrade a GPU to liquid cooling (go.pcworld.com/uplc), that's an advanced topic—and an expensive one if you mess up. Most people leave the GPU cooling as it is and look toward improving the CPU cooler.

Many CPUs come with a stock cooler, or if you're on a budget you might grab the cheapest serviceable CPU cooler you can find. But going the cheap way on the CPU fan



The Noctua NH-D15 CPU cooler.

is a mistake, because getting a better CPU cooler can help keep overall system temperatures lower. A better cooler can absorb more heat and direct it toward outtake fans, making the entire system more efficient. The problem with better CPU coolers is they can often cause problems for cases with low clearance. If they are oriented incorrectly, a large cooler may also prevent proper installation of your RAM.

One effective alternative to standard CPU coolers is the all-in-one (AIO) liquid cooler. An AIO removes any worries about clearance, and most cases have space for the fans an AIO requires. A dual-fan AIO is an excellent choice for keeping your CPU cool, and these days they often cost about the same as a high-end air cooler.

OTHER CONSIDERATIONS

If improving your case fans, adjusting negative versus positive pressure, and better component coolers don't help your situation, there are more possibilities.

First, it may be that your case simply isn't ideal for your system. Consider buying a new case that prioritizes cooling with better airflow and more space for fans. You may even have to give up on having a transparent side in exchange for more vents and spots for fans. Our topic explaining how to buy a PC case (go.pcworld.com/bpcs) can help you find the best case for your situation.

Also consider the ambient temperature in the room. Moving the PC to a room with air conditioning, if one is available, or a room in a below-ground basement is a good idea. If neither is an option, the old trick of pointing a floor fan at an intake filter can be surprisingly effective.

Keeping your PC cool is not always a simple affair, but for most people who aren't doing extreme overclocking with their systems, these steps should be enough to keep things from overheating.

As a final resort, you may need to replace your PC's case.

Buying a mechanical keyboard? Consider these 6 points of caution

Mechanical keyboards make for better gaming and more satisfying typing, but don't go in blind. **BY JARED NEWMAN**

When I bought my first mechanical keyboard in 2015, I had no idea what I was doing. Coveting the clackety sound and glorious key travel of mechanical switches, I sprung for a hefty Rosewill Apollo keyboard without doing much research. It ended up being a poor fit for me, and I ended up selling it on eBay a few years later.

Only later did I realize the depth of the mechanical keyboard rabbit hole (go.pcworld.com/mkrh), and how many granular options exist to get exactly the typing or PC gaming experience you want. After buying my first compact mechanical keyboard—then another,

IMAGE: HYPERX

and another—I realized there was no going back to cheaper keyboards with mushy rubber membranes and blandly utilitarian aesthetics.

If you're considering a mechanical keyboard yourself, don't make the same mistakes I made. Here's everything I wish I'd done before buying my very first model.

1. DO YOU REALLY NEED 104 KEYS?

While some gamers and Excel wizards might consider a number pad nonnegotiable, mechanical keyboards come in all kinds of sizes that eschew the standard 104-key format. You can lop off the number pad for an 87-key layout (as seen on the HyperX Alloy FPS Pro [go.pcworld.com/hyrx]), or you can get even more compact with an 84-key layout (go.pcworld.com/84ky) that omits dedicated Insert, Scroll Lock, and Number Lock keys.

The smaller you go from there, the more often you'll have to hold a Function button to access certain keys. My Qisan keyboard (go.pcworld.com/qisn) omits the entire F-key row along with the Print Screen, Pause, and Scroll Lock keys, while my semi-portable Anne Pro 2 (go.pcworld.com/anp2) comes without arrow keys. Some keyboards even take those constraints to the extreme by dropping the number keys (go.pcworld.com/dnky). Having a specific size in mind will narrow down your options significantly.

2. CONSIDER A KEY SWITCH TESTER

Different mechanical keyboards use different switches, and all have a big impact on how typing feels and sounds. Even within the broad categories of clicky, tactile, or linear switches, you'll find variations in stiffness and feedback.

Clicky Blue key switches, for instance, feel light under your fingers and make a loud click as you press partway down, while White keys have a similar sound with more stiffness. Tactile Brown switches aren't nearly as noisy, but they still make a little bump under your fingers as you press them. Linear Black and Red switches press straight down with no interference, with the former being stiffer than the latter. And while some keyboards are hot-swappable

Qisan's MagicForce keyboard has just 68 keys, so it doesn't take up much space on your desk.

A keycap tester is well worth the investment to learn which switch types you like best.

so you can easily move to a different switch type, most require soldering skills if you change your mind.

If all this seems overwhelming, an inexpensive $12 switch tester (go.pcworld.com/swte) is a great investment. You'll get to see what all the major switch types feel and sound like, and it's way better than any fidget spinner for stress relief.

3. DON'T CHEAP OUT ON SWITCH QUALITY

With mechanical keyboards, the brand of key switch is arguably more important than the maker of the keyboard itself. I learned this the hard way after buying a keyboard with generic Blue switches, only to discover that it sometimes failed to pick up every keystroke, and I quickly returned it for a keyboard with name-brand Cherry MX Blue switches instead.

Some folks do swear by certain Cherry competitors—mainly Gateron and Kailh—and some big keyboard brands such as Logitech (go.pcworld.com/g613) have their own custom switches. But steer clear of keyboards that only specify a switch color with no brand, and watch for sneaky language such as "Cherry Red equivalent."

4. KNOW YOUR KEYCAP TYPES

Keycap types are a rabbit hole within a rabbit hole, with a wide range of styles and profiles to choose from. If you're just getting started with mechanical keyboards, the important acronyms to look for are ABS and PBT, as your keyboard is likely to ship with one or the other. The former are smoother and shinier, but their key symbols tend to fade over time and they're more likely to show the grease from your fingers. The latter have a rougher finish that does a better job hiding the grime.

5. PLAN FOR STYLE AHEAD OF TIME

Of course, part of the fun with mechanical keyboards involves buying your own aftermarket keycaps to customize the look and feel of your keyboard. Sites like Banggood (go.pcworld.com/bngd) and AliExpress (go.pcworld.com/alxp) offer keycap sets for as little as $20, or you can splurge on designer sets through sites like TheKey.Company (go.pcworld.com/kycp) and Drop (go.pcworld.com/drky).

If you plan to go this route, make sure to buy a keyboard whose body color and backlighting matches the style you want to create. You don't want the keycaps you love to be a mismatch for the keyboard you just bought.

6. CONSIDER THE CONNECTIONS

Wired USB connectivity is still the default for mechanical keyboards. While wireless Bluetooth options exist—the Anne Pro 2 (go.pcworld.com/anp2) and Keychron K2 are notable examples—you'll be more limited in size and style if you go that route. If you're not planning to travel with your mechanical keyboard, foregoing the Bluetooth connection might make more sense.

On a related note, some wired mechanical keyboards have a USB passthrough port for plugging in a mouse, game controller, or other accessories. (The Das Keyboard 4 Ultimate [go.pcworld.com/dk4u] even has two of them.) That can be a great addition if your computer's port selection is limited.

WHY BOTHER?

From the outside, I admit it can seem unusual to put this much thought into a keyboard, especially if you're not invested in mechanical keyboards for gaming performance. But if you do any significant amount of writing on a computer, you'll be interacting with your keyboard constantly. Buying a mechanical keyboard is akin to investing in a high-quality, long-lasting tool that you can take pride in using.

As for the aforementioned rabbit hole—buying multiple keyboards in different sizes, each with its own switch type and keycap color—that's probably a little crazier. But don't be surprised if the thought crosses your mind once everything clicks for you.

daskeyboard

The Das Keyboard 4 Ultimate's dual USB ports come in handy for adding a mouse or game controller.

4 killer tab search tricks for Chrome and Microsoft Edge

Before you open yet another browser tab, try these tools instead. **BY JARED NEWMAN**

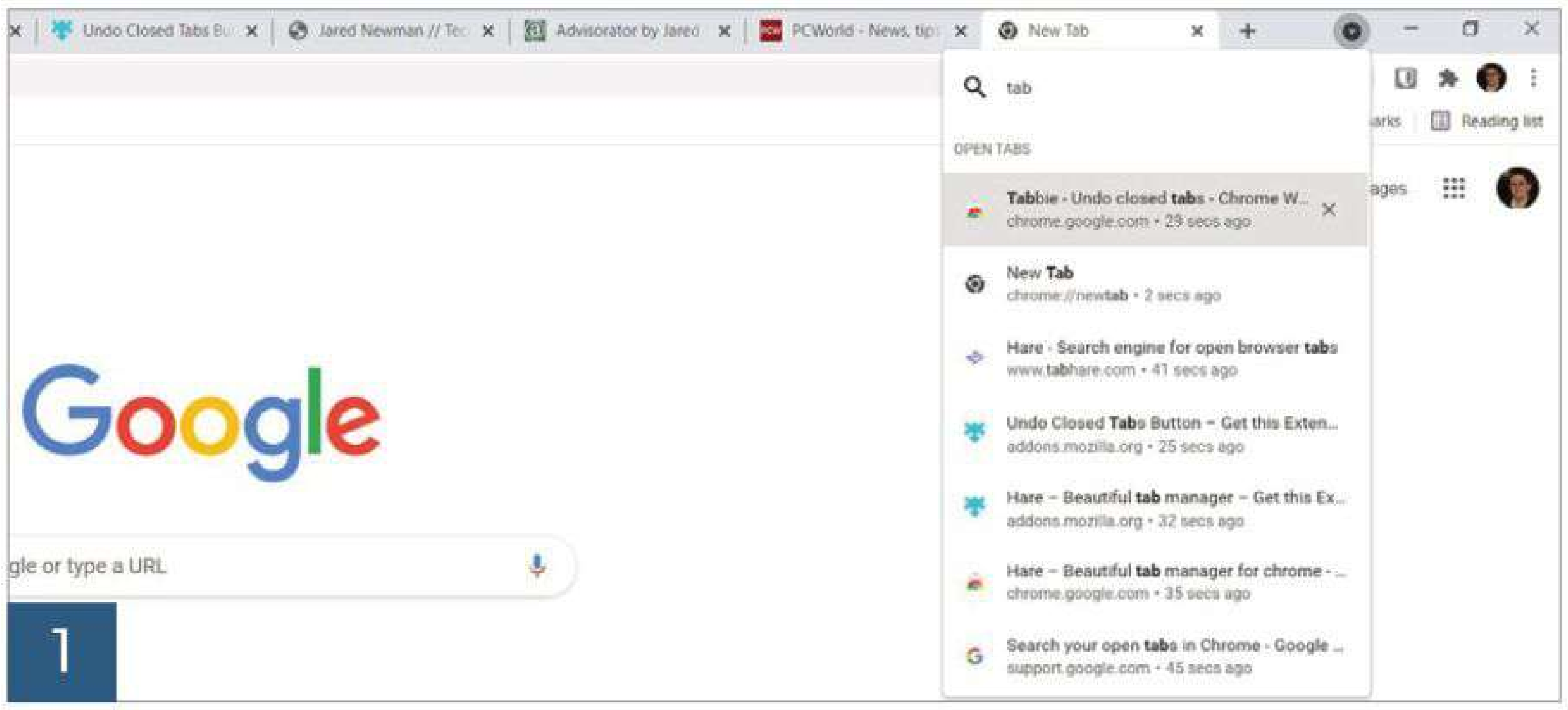
We've all, at some point in our computing lives, dealt with browser tab overload. But instead of giving into that helpless feeling—and loading yet another version of a tab you've probably got open already—consider the alternatives. These days, there are lots of ways to quickly sift through your open or recently closed browser tabs, sparing you the tedium of having to click through each one to find what you're looking for.

Here are four tricks you can use in Chrome, Edge, and other Chromium-based browsers to instantly get back to what you're looking for.

1. USE CHROME'S BUILT-IN TAB SEARCH

Over the summer, Google added a nifty tab search tool to its browser, one that you can operate exclusively with keyboard shortcuts. Just press Ctrl+Shift-A, and you'll see a list of open tabs in the browser's top-right corner,

IMAGE: PEXELS



tab

OPEN TABS

Tabbie - Undo closed **tab**s - Chrome W...
chrome.google.com • 29 secs ago

New **Tab**
chrome://new**tab** • 2 secs ago

Hare · Search engine for open browser **tab**s
www.**tab**hare.com • 41 secs ago

Undo Closed **Tab**s Button – Get this Exten...
addons.mozilla.org • 25 secs ago

Hare – Beautiful **tab** manager – Get this Ex...
addons.mozilla.org • 32 secs ago

Hare – Beautiful **tab** manager for chrome - ...
chrome.google.com • 35 secs ago

Search your open **tab**s in Chrome - Google ...
support.google.com • 45 secs ago

1

along with a search box and any tabs you've closed recently. (You'll also see some recently closed tabs, provided you don't have too many open ones.) Type the title of the page you're looking for, then hit Enter, and you'll immediately jump over to the appropriate tab.

If you ever forget how to open this menu with your keyboard, just click the little down arrow to the left of the minimize window icon. That'll bring up the same tab search menu, with the corresponding keyboard shortcut at the top.

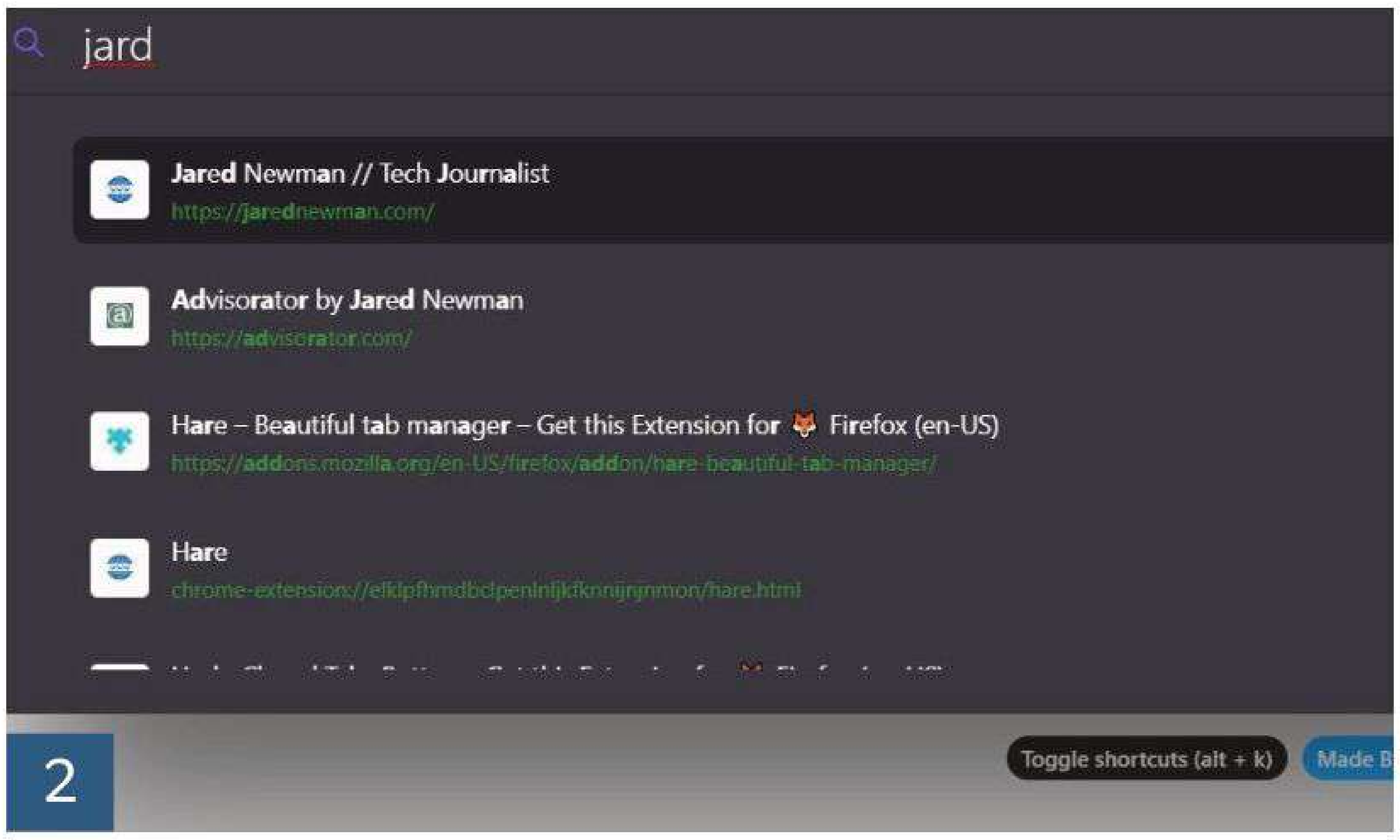
Note that both Chrome and Microsoft Edge offer a separate "Switch to this tab" button from inside the main address bar, but you can't activate this button with just your keyboard, unlike the dedicated search menu.

2. TRY THE TAB HARE EXTENSION

For an even better search experience that works in practically every major browser, check out Tab Hare (go.pcworld.com/tbhr), a free extension for Chrome, other Chromium-based browsers (such as Microsoft Edge), Firefox, and Safari.

After installing the extension, press Ctrl+Shift-Space to bring up a search window. Type the name of the tab you're trying to find, then use the arrow keys and Enter to pick it from the results list. There's also a handy "previous tab" feature, which lets you toggle between two recent tabs by pressing Ctrl+Shift-U. (Sadly, this feature doesn't work in Edge, because it conflicts with Microsoft's Read Aloud text-to-speech function—more on this shortly.)

Compared to Chrome's search tool, Hare is better at locating tabs even when your query doesn't exactly match the page title, and its placement at the center of the screen makes it easier to use. While it's not the only browser extension of this kind, I like how unbloated it is compared to other tab



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Jared Newman // Tech **J**ou**r**n**a**list
https://**jared**newman.com/

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Hare – Beautiful tab manager – Get this Extension for 🦊 Firefox (en-US)
https://**add**ons.mozilla.org/en-US/firefox/**add**on/hare-beautiful-tab-manager/

Hare
chrome-extension://elklpfhmdbdpenlnljkfknnijnjnmon/hare.html

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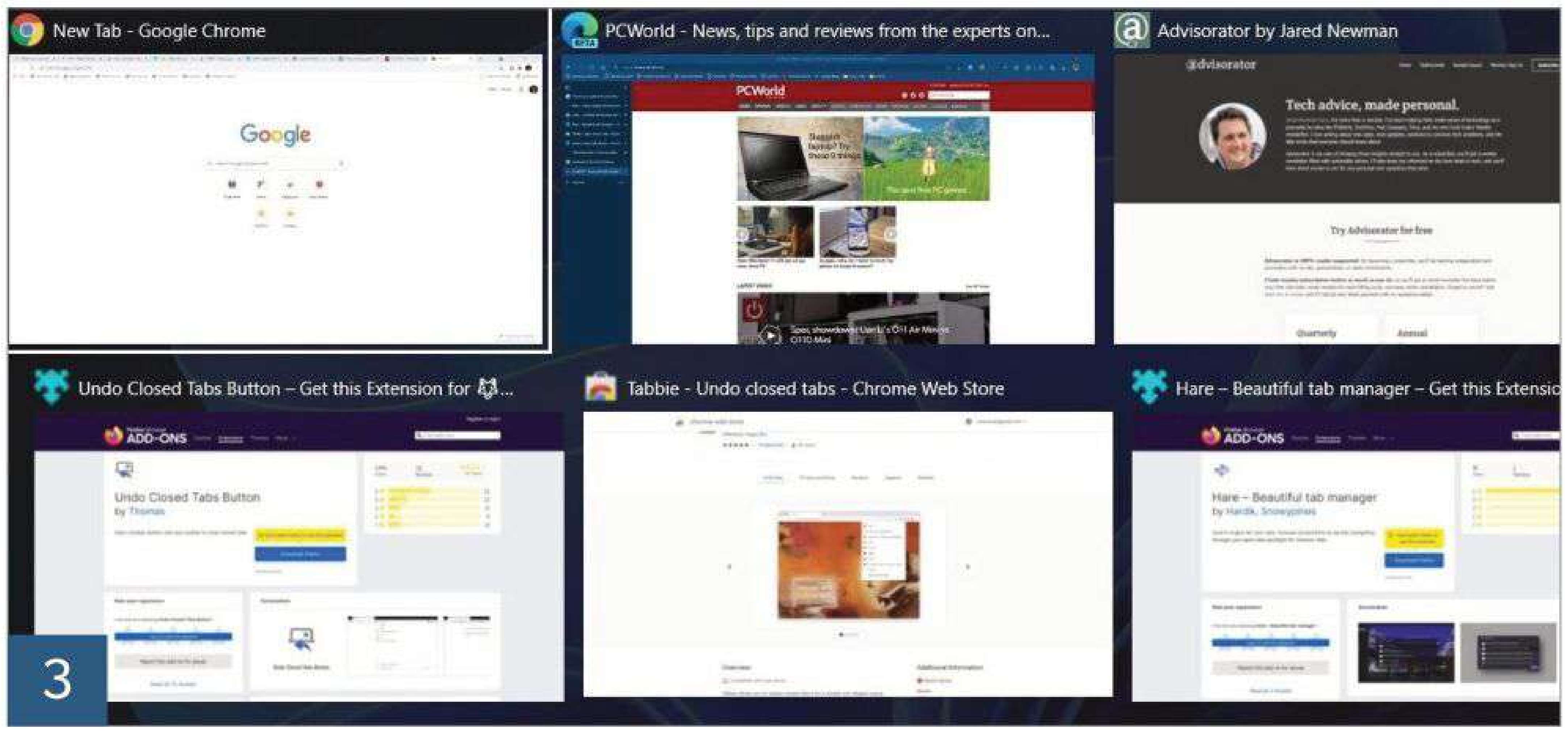

New Tab - Google Chrome
PCWorld - News, tips and reviews from the experts on...
Advisorator by Jared Newman
Undo Closed Tabs Button – Get this Extension for
Tabbie - Undo closed tabs - Chrome Web Store
Hare – Beautiful tab manager – Get this Extensio

3

search tools, which often try to stuff in unnecessary features. It's an extension that does one thing well.

3. USE ALT-TAB WITH MICROSOFT EDGE

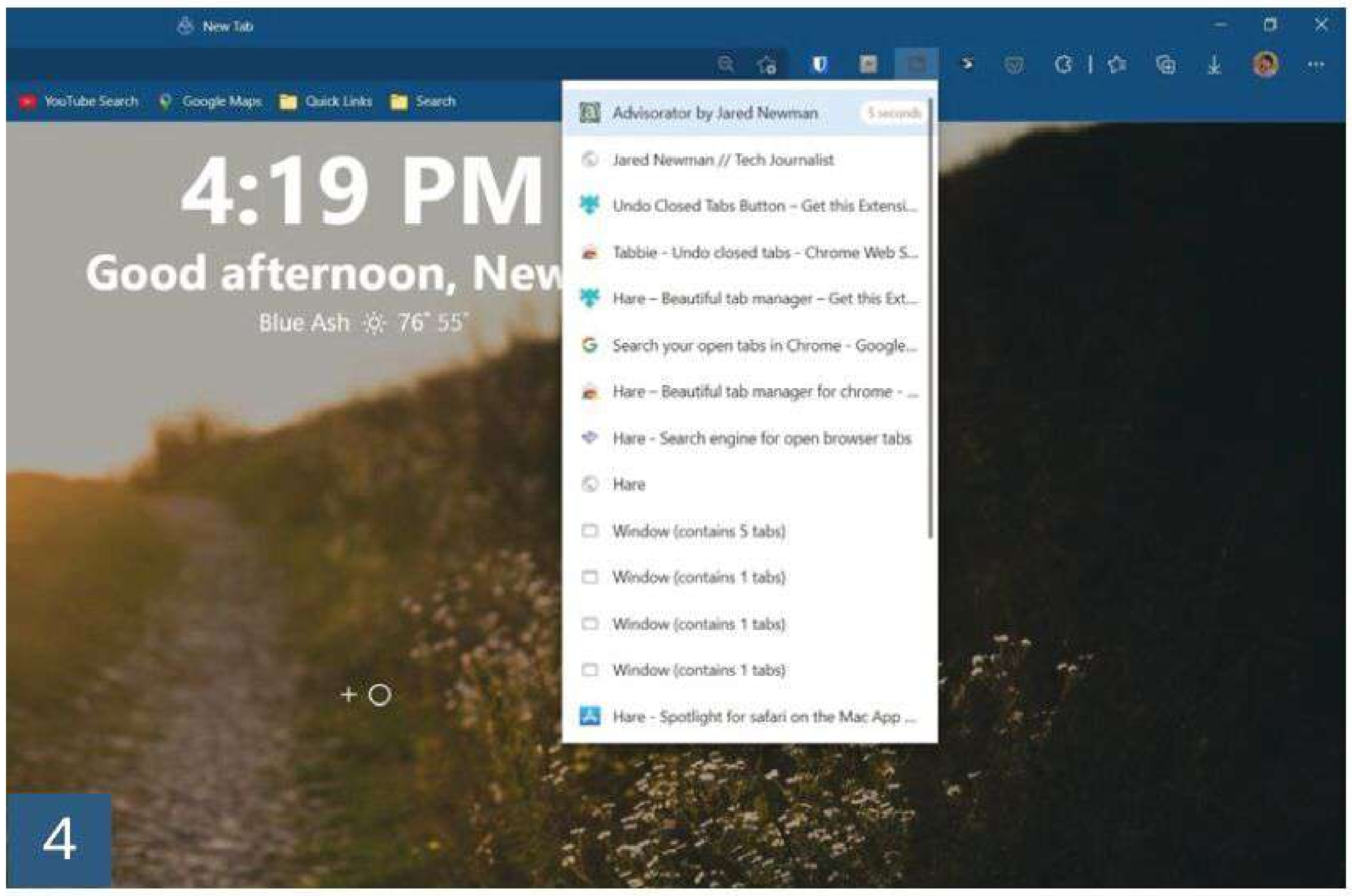
With Microsoft Edge on Windows 10, you can quickly switch between recent tabs without having to hunt for them in your browser bar. Just press Alt+Tab as you normally would to switch apps, and your five most recent tabs will appear in the Windows multitasking menu.

If five tabs feels like too many—or too few—for your Alt+Tab menu, head to Windows Settings > System > Multitasking and look for the Alt-Tab section. From here you can choose to show just your three most recent tabs or all of them.

4. RECOVER CLOSED TABS WITH TABBIE

Earlier, I mentioned how Chrome's tab search feature includes a list of recently closed tabs as well. While this is a useful feature, it only shows your eight most recently closed tabs, and it can be hard to look through if you've also got a lot of other tabs open already. Likewise, features like Reopen Closed Tab in Chrome can only recover one page at a time.

As an alternative, check out a free extension called Tabbie for Chrome and Edge. It adds a button to your browser toolbar that shows all the tabs you've recently closed in a pop-up menu, and it lets you recover closed windows as well. You can also customize how many tabs appear here and see how many minutes ago you closed each one. While you could always just wade through your browser's history list to recover old tabs, Tabbie does the same job with far less hassle.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YouTube Search
Google Maps
Quick Links
Search
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Good afternoon, New
Blue Ash 76° 55°
Advisorator by Jared Newman
5 seconds
Jared Newman // Tech Journalist
Undo Closed Tabs Button – Get this Extensi...
Tabbie - Undo closed tabs - Chrome Web S...
Hare – Beautiful tab manager – Get this Ext...
Search your open tabs in Chrome - Google...
Hare – Beautiful tab manager for chrome - ...
Hare - Search engine for open browser tabs
Hare
Window (contains 5 tabs)
Window (contains 1 tabs)
Window (contains 1 tabs)
Window (contains 1 tabs)
Hare - Spotlight for safari on the Mac App ...

4

Tech Spotlight

A video showcase of the latest trends

msi
EVGA | GEFORCE GTX 1660Ti
AORUS
GIGABYTE
GEFORCE GTX

Watch the video at go.pcworld.com/011

Lian Li's O11 Air Mini vs O11D Mini

⇢ Lian Li's new 011 Air Mini case may look like the incredibly popular Dynamic Mini, but they're more cousins than siblings. We run through their details to help you choose between the two.